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III. TWO PRE-HUNTERIAN OPERATIONS FOR ANEURYSM

JOHN HUNTER would sometimes have saved himself trouble had he been more conversant with the literature of his own profession. He took infinite pains to study the effects of arterial ligature before he tied the femoral in its continuity to cure an aneurysm at St. George's Hospital in December, 1785. Richard Wiseman (1622–86) records two cases in which he tied the main artery more than a hundred years earlier. Both operations were undertaken in the ordinary course of his surgery, and both were successful. The first case was certainly done before 1672, for the details of it are printed in the rare first edition of his works.* He says :—

"A Cooper living near Maidenhead in the County of Bucks, accidentally in letting bloud was prickt in an Artery, the Arm swells and is pained, he puts himself into another Barber Chirurgions hands dwelling in Windsor, who by unfit applications, Relaxes the part, then supposing the soft Tumor he had made was a Suppuration of Matter, (though indeed it was the Arterial bloud) he with his Incision knife or Lancet cutts into it, at which an impetuous flux of bloud rushes out, to the quantity of four flaggons, he fills up the opening with Lint, and makes a hard bandage round it, which somewhat restrains the flux of bloud, but the Arm swells, and threatens a Gangreen.

"While this poor man lay thus afflicted, We, his Majesties and Royal Highness Chirurgeons attending the Court, did Visit him, and proposed to make an apparatus for the taking up this Artery, or in case of failing to take off his Arm by Amputation; We met the next morning, the Patient is taken out of bed and placed in a Chair towards the Light, one of his friends held him in the Chair: Mr. Whittle stood behind his Arm, and held his Elbow with his left hand; and with the other hand was ready to help me in the operation; Mr. L holds the lame hand:

"In the first place I viewed the Arm, where finding no Gangreen according to the report of the Chirurgeon, but rather (as I thought) an Aneurisma, I made

* *A Treatise of Wounds* by Richard Wiseman, 8vo, London, 1672, p. 43. Printed by R. Norton for Richard Royston, Bookseller to His most Sacred Majesty.

a bandage above the wound, to hinder the Influx of bloud into it: Upon this bandage Mr. Pearce made the gripe; I then untied the Ligature from about the wound, and found that also free from Mortification; I put my finger into it, and finding the skin made thin by distention from the bloud, I call'd for a Knife, which while I was searching in the wound, Mr. Whittle took into his hand: I prayed him to cut through the length of the hollowness. It being done, I with my finger thrust out the Grumous bloud and an Absces from the lower part of the Arm. When I had cleared the parts more distant, which would have fallen in and blinded my Work, I then made way to the Artery, removing from about it the clotted bloud; upon which it immediately burst out, I prayed Mr. Whittle to hold his finger upon it, he did so; then I separated it from the parts about it, and passed a crooked Needle under it; and being ready to tye it, I desired Mr. Whittle to hold off his finger, that I might be the more sure it was the Artery, upon the doing of which it spurted out: I tyed it; but in tying the Thread broke: This caused a murmuring in some of the by-standers, as that the Patient would die under our hands while I was endeavouring deligation, which by a new wounding of the parts would hasten Mortification and Death; I desired they would continue their places, and Mr. Whittle his finger upon the Artery, that it bled not; he did so; in the while I made a strong Ligature of some twisted Threads, seared it, and put it into the eye of one of our common silver searching-Probes. Gentlemen, said I, you shall see me pass this Probe under the Artery, and thereby you may be assured I shall wound no parts; I immediately did so and tyed the Artery, Mr. Whittle took off his finger, it bled not; then Mr. Pearce took off his hands, I then loosened the Bandage, which was all the time before under his hands, It bled no more:

"I told them there was more to be done in order to the binding that Artery; but in consequence of the continual Fainting of the Patient, we would defer it to the next dressing: then calling for dressings, they brought me what was designed for Amputation, which I refused; and ordered the common digestive *e Terebinth. cum Vitell. ovi*, which they fetcht. I cut off the ends of the Ligature, and dipt some of the pledgits spread with the Liniment in Galen's powder, and applyed them next the Artery, and the rest of the pledgits dipt in *ol. Ros.* warm, and lightly fill'd up the wound, then Embrocated the Arm with the same oyl, and laid a *Diacalcitheos* Emplaster over the wound and that part of the Arm, and over the hand and Arm below which was Oedematous, a mixture of *Diacalcith. Paracels. &c.* Then with bandage began at the hand and rouled up the wound, and taking a turn or two there, I rouled up to the Axilla. This was the *Ligatura Expulsiva*, by which I proposed the thrusting back the Influx of humors, and to give strength to the infeebled Member; He being now again in his Bed, I placed his hand upon his breast in much ease to the great joy of the Patient.

"At the next dressing, only Mr. Whittle and the Countrey Chirurgeons were present with me, we opened the Member, found the tumor allay'd, the wound fresh and tollerably digested, we now passed another Ligature upon the Artery above the first, and in pulling the first to cut it off between the Ligatures, it broke, which was as well: We drest it up with the same digestive, only leaving out the Powders; Embrocated and applied our Emplaster, rouled up the parts as before.

"The next time Mr. Whittle and I undrest the member, and found the wound in a very good condition, with assured hopes of curing it in a few weeks, the Lips of the wound being more digested and contracted, we drest it up with *Mund.*

Paracels. And now being Impatiently expected at London, with my diseased Patients, I return, leaving it to Mr. Whittle, who drest it for the space of 10 dayes, it healing up without any return of bloud; In his absence Mr. L. dressed the Patient, but whether in wiping off the knot or what else, it burst out again; Sergeant Knight came in, dressed it with *Calcanth. ust.* and from that time it bled no more.

"The Ancient way of tying this Artery is, as I have already said, by tying it in two distinct places, and cutting it off between, but here the Patient often fainting interrupted us in that work, and the breaking between saved us the labour."

The case is reported again in Wiseman's *Several Chirurgical Treatises* (p. 356), published in 1676, but in preparing it for the press he modified the account.

Of the actors in the scene, John Knight took his B.A. from Caius College, Cambridge, in 1622, was surgeon to King James I, and was Serjeant Surgeon to Charles II in 1661. Mr. Pepys records that he "dined with Mr. Knight, chief chyrurgeon to the King, and his wife" on New Year's Eve 1662. "We were pretty merry, he being excellent Company." Richard Wiseman was appointed Serjeant Surgeon in 1672 and was Master of the United Company of Barbers and Surgeons in 1665. James Pearce was surgeon to the King, Charles II, and to the Duke of York, afterwards King James II. He was Master of the Barber Surgeons Company in 1675. Mr. L. may possibly have been Lawrence Loe, the King's Barber, who was Master of the Barber Surgeons Company in 1667. It is more likely, however, that he was the local practitioner whose name can no longer be recovered.

(*To be continued*)

FRACTURE OF THE FEMUR WITH LUXATION OF THE IPSILATERAL HIP *

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INTRODUCTION

It has been our fortune to treat the only two cases of this rare association of injuries that were recorded in an aggregate of 9945 fractures and luxations at Kasr el Aini Hospital during the past eight years (1925–32). In this period the patients admitted to the wards numbered 151,663. These two cases, therefore, of femoral fracture with hip-luxation form an incidence among the total admissions during these eight years of 0·0013 per cent, a rate of 13 per 1,000,000. Their incidence in the aggregate of all the luxations and fractures treated at Kasr el Aini Hospital in the same period is 1 case in about 5000, or 0·02 per cent.

Future studies of larger series will exactly define the rarity of hip-luxation with femoral fracture; meanwhile the Kasr el Aini figures show that the combined injury is rare.

An account of our two cases will serve to preface a study of the different varieties of this fracture and luxation, which is based on all the records that we could find in the small and scattered literature of the subject. We shall first set aside the fractures caused by attempts to reduce luxations of the hip, and shall postpone the consideration of these surgical accidents till we have dealt, in *Part I*, with the 42 cases in which the luxation and fracture have formed successive events of an immediate traumatic sequence. The first in this sequence is probably always the luxation, but we have decided to classify the varieties of the combined injury in terms of the fractures. This classification will be more readily accepted than one according to hip-luxation, for which definitive terms have not yet been fixed. Further, it is the break in the femoral lever that dominates the question of treatment. The cases, therefore, which we believe to be authentic will be grouped under four headings according to whether the femoral fracture affected (1) the head, (2) the neck, (3) the shaft, or (4) some other portion of the femur. Cases which at any time have passed muster in previous accounts, but where the diagnosis of the combined injury has appeared questionable, will be summarized in footnotes.

THE AUTHORS' TWO CASES

Case 1.—**Fracture of the femoral shaft with hip-luxation.—**

K. A., a strong, healthy, woman, aged 64 (Hospital No. 15055, year 1928), was admitted to Kasr el Aini Hospital on Nov. 19, 1928, with a fracture of the right femur in the upper

* From the Surgical Unit, Kasr el Aini Hospital, Cairo.

third, 6 in. distal to the top of the great trochanter, and a luxation of the head of the right femur on the dorsum ilii, both conditions being found by X-ray before she was referred to us (*Fig.* 144). The total shortening due to the two injuries was about 4 in. The proximal fragment was markedly flexed, while the distal was drawn up behind it.

One unsuccessful attempt to reduce the luxation by 'closed' methods had been made before she was admitted to our Surgical Unit, and after admission a second attempt was equally unsuccessful. By this time three weeks had elapsed since the original injury, and we believed that nothing but an 'open' operation could give us sufficient control of the short upper fragment to effect reduction of the hip.

FIG. 144.—*Case* 1. The fracture of the femoral shaft and the hip-luxation.

OPERATION. — After preparing the patient's rather rough dry skin for four days with a 1 per cent aqueous solution of mercurochrome, we made the ordinary Smith-Petersen incision for exposing the hip-joint, continuing it well down into the middle of the thigh, after the method described by one of us, to expose the femoral shaft. There was a negligible loss of blood and the condition of this hale and energetic patient was admirable throughout the operation. The incision gave an ample exposure of the joint and of the site of fracture, but it was impossible, even with lion-forceps, to apply sufficient traction on the upper fragment to reduce the head. To get better control we bored through the upper fragment just below the great trochanter and passing a 2-ft. length of $\frac{1}{8}$-in. iron wire through the hole we bent it into a ring, and with padding made it comfortable for manual traction. After pulling for about one minute, the head, pushed also from behind, suddenly slipped into place, and so silently that we at first were unaware of its reduction, the fact of which, however, we soon verified in the wide wound. After removal of the wire ring, and partial reduction of the fracture by manipulation, the muscular planes were closed with interrupted sutures of unchromicized gut; skin-closure was effected entirely with Michel clips. Strapping was then applied to the leg and lower part of the thigh, and the limb was extended by traction in full abduction in a straight Thomas splint. The wound healed perfectly and the patient's convalescence was uneventful, though her energy more than once threatened to compromise the undisturbed union of the fracture.

FIG. 145.—*Case* 1. The hip-luxation reduced by operation. The shaft-fracture has united.

An X-ray taken a fortnight after the operation confirmed the presence of the femoral head in the acetabulum. The reduction of the fracture, however, was only approximate, but was nevertheless sufficiently good, and we did not again disturb the patient. (*See Fig.* 145, from an X-ray three months after operation.)

AFTER-TREATMENT. — Massage was begun in the third week after operation, and on Dec. 29, 1928, forty-seven days after operation, a plaster spica was applied. This was changed twenty-eight days later, and on March 4, 1929 (113 days after operation), she walked with a caliper, in which she was discharged.

END-RESULT.—Two years later, in May, 1931, with the greatest difficulty—for this nomadic person had changed her address fourteen times—the patient was brought back to Kasr el Aini Hospital for examination, largely through the efforts and courtesy of Ahmed Moukhtar Pasha Hegazi. Her condition is well seen in the accompanying photographs (*Figs.* 146–148).

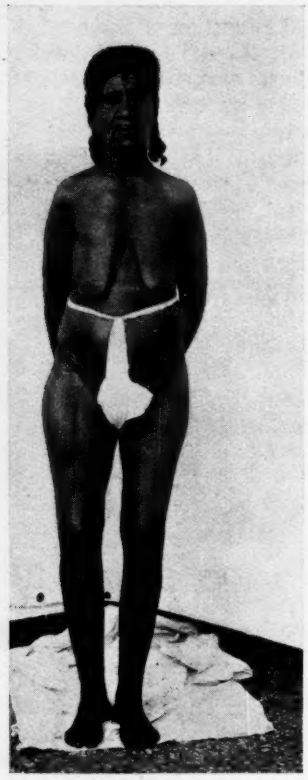

FIG. 146.

FIG. 147.

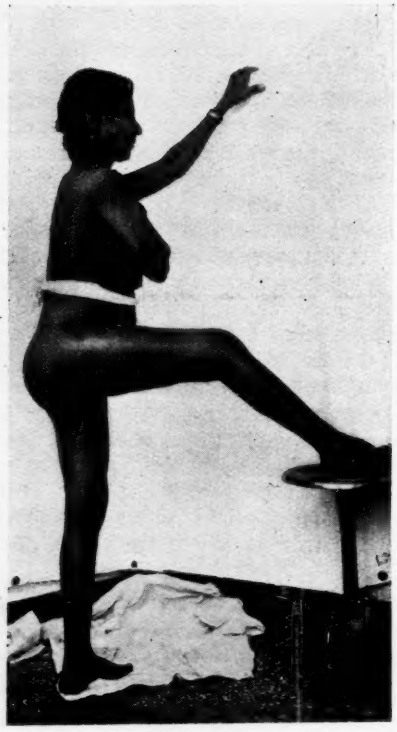

FIG. 148

FIG. 146.—*Case* 1. The patient two years after operation.

FIG. 147.—*Case* 1. Showing maximum abduction of the lower limbs.

FIG. 148.—*Case* 1. Showing the maximum flexion of the hip possible in the injured limb two years after operation.

Case 2.—**Fracture of the femoral neck with hip-luxation.**

The patient, H. I., a male (Hospital No. 19696, year 1931), was admitted on Oct. 18, 1931, ten days after a fall. He gave his age as 60, but he looked at least ten years older. He stated that as he was going along the pavement he slipped on a piece of banana peel and fell with his legs apart. He was lifted to his feet by those who came to help him, but he could not walk. He was then conveyed to his own house, where he remained for ten days before coming to hospital. On admission the left lower limb was everted and was shortened ¾ in.; the upper part of the left thigh showed signs of contusion; there was crepitus, and the proximal fragment of the neck formed a hard prominence in Scarpa's triangle, which at first was mistaken for the projecting end of the shaft, broken at the upper third.

When he was first seen by us an X-ray had already shown the fracture of the femoral neck and the peculiar forward and downward displacement of the dislocated head that is seen in *Figs.* 149, 150. The manipulations that would have been necessary to establish

FIG. 149.—*Case* 2. The fracture of the femoral neck and the hip-luxation.

FIG. 150.—*Case* 2. The luxated head shown in anterior lateral view.

the distal part of the femoral neck in the acetabulum seemed imprudent in the presence of the dislocated proximal fragment which projected in the neighbourhood of the femoral vessels, and, encouraged by our success in the first elderly patient, we decided to resect the proximal fragment and then implant the remnant of the femoral neck into the acetabulum.

OPERATION.—Two incisions were made. The first, medial to the femoral artery, exposed the proximal fragment, which had burst through the fibres of the pectineus close to the psoas muscle. It lay firmly lodged with its articular surface directed proximally and backward, while the profunda artery and vein together with their circumflex branches and tributaries were tightly stretched over its sharp wedge-shaped distal end, which projected forwards and down through the torn pectineus. The fragment was extricated with some difficulty from its dangerous contact with the vessels. Since it was impossible to reach the acetabulum through the first incision, a second was made between the sartorius and the tensor fascia femoris, which gave just sufficient exposure for clearing the acetabulum, and for implanting therein the sharp distal remnant of the femoral neck. The limb was held in abduction and inversion while the two incisions were closed, and was kept in this position upon a Thomas splint. The wounds healed perfectly, and a plaster spica was applied on the eighth day, when the Michel clips were removed. Unfortunately the patient refused absolutely to stay in hospital. A month later he returned with 3 in. of shortening, wearing a few filthy scraps of the spica, which he had broken to pieces. A walking caliper was made for him, but he refused to learn its use and was discharged.

PART I

FRACTURES OF THE FEMUR WITH HIP-LUXATION DUE TO ORDINARY TRAUMA

I. FRACTURES OF THE HEAD OF THE FEMUR WITH HIP-LUXATION

Apart from "impaction within the limits of the head", of which Cotton has seen three cases, it is the rule for fracture of the femoral head to be associated with luxation of the hip. We have found thirteen cases of this association of injuries in the literature, and only one authentic case—recorded by Levin in this JOURNAL—in which an unimpacted fracture of the femoral head occurred without the luxation.

Sex and Age Incidence.—Of the thirteen cases of head-fracture with luxation, eight were male and five female. The oldest patient was 60, and the youngest was 15. The age in one case is not stated. Only two patients were under 30. The average age was $38\frac{9}{12}$.

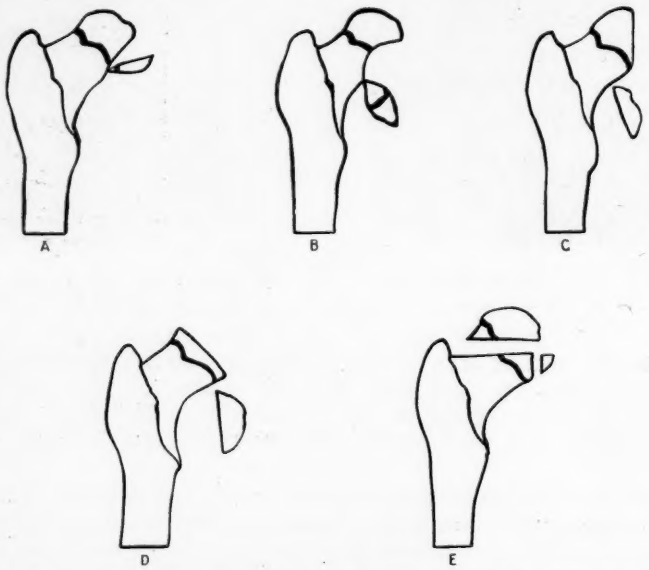

FIG. 151.—Typical fractures of the femoral head. A, Braun's case; B, Crile's; C, Christopher's; D, Satta's; E, Riedel's. (*After Christopher.*)

The Hip-luxation.—This is always in a backward direction. In seven cases it is described either as 'posterior' or 'dorsal'. In six the description makes it clear that the luxation was on to the dorsum ilii; in one case it was sciatic.*

The Fracture of the Femoral Head.—Various fractures of the femoral head are illustrated in *Fig.* 151. In two cases, Riedel's and Nichiarelli's, the head was fractured in more than one place, and in one of these (Riedel's), the oblique fracture

* While the majority of authors agree in limiting the term 'dorsal' to luxations on the dorsum ilii, others employ 'dorsal' to signify 'backward' or 'posterior', and thus make the term 'dorsal' include the iliac, sciatic, and ischiatic luxations. It is sometimes impossible to discover from the records of femoral fracture with luxation whether the term is used in its wider or narrower connotation.

ran also into the neck. In one case (Robert's) the neck was separately fractured, but it seems probable that this fracture occurred during an attempt at reducing the luxation. In four cases a piece of the head remained in the cavity of the acetabulum, and in one it rested on its posterior lip.

Stimson's case is unique in presenting a groove on the anterior surface of the femoral head, parallel with and close to the edge of the articular cartilage, 1 in. long, $\frac{1}{2}$ in. wide, and $\frac{1}{8}$ in. deep, along which the cancellous structure of the bone was exposed. This groove was made by an exostosis close behind the rim of the acetabulum. Stimson compares the injury to that occasionally produced in the humeral head by impact on the glenoid edge during the course of anterior luxation.

In four of the cases there was an associated fracture of the acetabulum: this, according to Tanton, is evidence of the manner in which the femoral head breaks (*see below* under 'Causation').

The Ligamentum Teres.—In four cases this ligament is mentioned: in two it remained with part of the head in the acetabulum. In Braun's case, where the fracture extended slightly into the neck of the femur (*Fig.* 151, A), the ligament was split longitudinally. In the fourth case (Hinsdale's) it is merely stated that the fragment which lay on the lower margin of the acetabulum included the insertion of the ligamentum teres.

Causation.—This is usually violence of a considerable degree. Three cases were due to train accidents, three to automobile accidents; one patient was thrown from a motor-cycle which fell on him. One fell from a cart; a sailor fell from the mast of his ship; a second fell through a hatchway; a woman fell 25 ft. on to the pavement. In one case the nature of the injury is not stated, and in only one (Hinsdale's) does the trauma appear to have been slight.

The violence of the trauma was sufficient to cause the death of four cases, one dying of cerebral injury a few minutes after admission, another "soon after admission", and a third in three days with a fracture of the skull-base and of eight ribs; a fourth on the tenth day. Another case in which the luxation was reduced by manipulation probably belongs to the category of death from violence, since there was also fracture of ten ribs with hæmothorax. This patient died nine hours after admission.

The history of the single case due to slight violence is remarkable: This right-sided fracture with luxation occurred, writes Hinsdale, "in a woman aged 55, whose weight was about 160 lb. She fell in attempting to jump from a motor-boat to a wharf: she had reached forward to take a hand offered to her, and in jumping tripped over the gunwale of the boat, and fell on the wharf, striking her *left* hip. She was immediately conscious of a severe injury, and stated that she had dislocated the *right* hip-joint. She was unable to rise or move the limb, and was carried a short distance to her home." (We have italicized the words 'right' and 'left'.) Hinsdale suggests that the contralateral luxation may have been due to the patient's catching her right foot on the side of the boat as she fell.

Christopher, in a study of this injury which has been our main source of information, adopts Tanton's view that the chief factor in these fractures is a force acting either in the long axis of the femur and towards its proximal end, or directly on the great trochanter: this force, they think, is suddenly applied in the course of the luxation in such a way that it breaks the femoral head against the acetabular rim, and this, according to Tanton, may also be fractured. "In all probability it

(the fracturing force) is always applied when the femur is flexed and slightly abducted" (Christopher). He discounts Birkett's theory that the pull of the ligamentum teres helps to break the head when the femur is driven upward and back, since, according to Cotton, the ligamentum teres is not strong and ruptures under a pull of 14 kilos.

Symptomatology.—

Shortening.—This is definitely recorded in four out of the thirteen cases, as 4 cm., 5 cm., 6 cm., and "about 3 in." (i.e., 7·5 cm.), respectively.

Posture.—Three authors report flexion, adduction, and internal rotation of the affected limb; one, flexion and adduction; one, flexion only; one, internal rotation only; one, adduction only; while in one case (Nichiarelli's) flexion was combined with *external* rotation—"The lower limb was rotated outward to such an extent that it lay with its lateral face on the bed". This rare condition of a dorsal luxation with eversion of the thigh was associated here with a fracture of the iliac lip of the acetabulum.

Movements.—Nichiarelli obtained passive abduction to 45°; his patient could flex her thigh by sliding the foot along the bed: other movements were absent. In Christopher's case slight extension was possible from the flexed position; in Satta's, passive movements were limited. No other authors deal specifically with movement.

Crepitus.—This sign was elicited on rotation in only two cases.

Moxon found a large dent in the skin just above the left tuber ischii.

Diagnosis.—According to Christopher, fracture of the femoral head with hip-luxation is to be suspected in patients presenting the ordinary signs of a posterior dislocation of the femur when there is in addition crepitus in the neighbourhood of the joint or unusual difficulty in reduction. Cotton mentions ease of re-dislocation as another suggestive sign. A positive diagnosis cannot be made without either an X-ray examination, operation, or necropsy (Satta). In six cases the fracture was discovered by radiography, in one at operation, and in six others at necropsy; in none was the diagnosis made from clinical signs.

Treatment of Head-fractures with Luxation.—In three of the thirteen cases under consideration no attempt at reducing the fracture or the dislocation is recorded: all three died soon after admission. (Robert's patient died, not from open reduction, but at once after an operation performed for resection of the femoral head, three months after the injury: he had almost succumbed during a previous unsuccessful attempt at 'closed' reduction under ether. Union of the fractured head had occurred in this case.)

Reduced Luxations.—In nine of the thirteen cases the luxation was reduced, in six by non-operative means, and in three by open operation, two patients in the first category dying shortly after reduction; both were 'bad risks'. In Braun's case the luxation that was reduced by manipulation on the day of injury was complicated by hæmothorax and the fracture of ten ribs. Crile's patient died three days after admission with fracture of eight ribs and the skull-base.

Non-operative Reduction with Survival.—Of the cases that survived, therefore, the luxation was reduced in four by 'closed' methods—in the case recorded by Platt, on the day of injury; in that of Christopher, after two days; in Nichiarelli's patient, after twenty days, and here partial union had occurred. In Durand's and Destot's case the interval between the injury and reduction is not recorded.

Platt's patient was first seen by him seven weeks after the luxation had been reduced by another surgeon. The fracture of the head was found by radiography, and a large piece of the head lying outside the acetabulum was removed from the joint through a posterior incision, after dividing the obturator externus. When seen by Platt the hip showed an almost complete range of mobility without discomfort. The primary object of his operation was to effect neurolysis of the sciatic nerve, which had been injured in the accident; the second was to remove the large separated portion of the head together with a slender fragment from the acetabular margin.

Nichiarelli mentions that he succeeded at the second attempt, "by the Paci-Lorenz method". Christopher is the only author who gives in detail the method of 'closed' reduction that he employed: "first, extreme flexion of the thigh, then extension to about 110 degrees, and then slow, steady abduction against considerable resistance. The fractured head slipped into the acetabulum with a crepitant sound. The motion in the joint at once became free." An X-ray after reduction showed the fragments of the head in excellent position.

Operative Reduction with Survival.—These were three in number—Hinsdale's case operated on by E. G. Abbott on the first day after the injury; Satta's on the fifth day; Riedel's after three months. In Hinsdale's case and in Satta's, prior attempts at 'closed' reduction had failed: in Hinsdale's "the head could be placed opposite the acetabulum but would not enter. Crepitus was felt in these attempts." Radiography showed the fragment lying on the lower margin of the acetabulum. Hinsdale merely states that the luxation was reduced after removing the fragment and that the case was afterwards treated for three weeks by extension followed by movement. In Satta's case reduction had been twice unsuccessfully attempted before admission to hospital. After admission the luxation was reduced on a traction-table, but the reduction could not be maintained. Satta therefore, after removing the fragment consisting of half the head from the acetabulum, covered the raw extremity with fascia; nineteen days later the luxation recurred: erysipelas and abscess followed a second arthrotomy.

Riedel merely states that he removed two fragments of the head and replaced what was left in the acetabulum.

Results.—In the seven surviving cases of head-fractures with luxation, four good results are recorded—three after 'closed' reduction, and one (Hinsdale's) after operation (by Abbott). Thus Christopher's patient walked with crutches eighteen days after the luxation was reduced, and without them in thirty days. On discharge, fifty-three days after reduction, she could walk a mile a day, limping from slight foot-drop due to sciatic injury. Seven months later she could walk four miles without limping. Nichiarelli's patient, examined soon after removal of the plaster spica, showed negligible shortening. There was a moderate ability to flex the thigh; abduction was slightly limited by a varus deformity at the site of fracture; the gait was free with a very slight limp.

The hip-joint in Platt's patient preserved the good mobility which it had seven weeks after a 'closed' reduction, so that a year later hip-movements were complete and painless, though the gait was still imperfect owing to the sciatic lesion due to the original accident.

Hinsdale's case could walk two months after operation, and in four months was "perfectly well".

Ankylosis.—This occurred in three of the surviving cases, who were aged respectively 15, 36, and 44. Riedel records in 1885 that when he removed the two fragments of the femoral head, three months after the injury, ankylosis of the hip occurred in the course of a further three months, accompanied, however, by only 2 cm. of shortening. Riedel's patient was aged 15. In Satta's patient, aged 36, operative reduction was followed by erysipelas and an acute arthritis caused the ankylosis. Durand and Destot record a partial and painful ankylosis in a patient aged 44 who was treated by 'closed' reduction.

Comment.—It is evident from the foregoing summary that good results can be got by non-operative reduction of the fractured and luxated head of the femur. 'Closed' methods therefore may be given a thorough trial.

Platt noted in his patient, who was aged 60, "the rapid restoration of excellent joint function, despite the presence of a large loose fragment", and it will be recalled that the fragment was afterwards removed incidentally, during an operation on the sciatic nerve, and not because it was causing disability. In Christopher's case, where a third of the femoral head remained in the acetabulum, "motion in the joint at once became free" after reduction. Nichiarelli, too, in his case aged 45, records "free mobility of the joint immediately after reduction".

Operation is thus indicated where 'closed' methods of reduction fail owing (1) to the patient's delay in coming for treatment (Riedel's case), (2) to an obstructing fragment (Hinsdale's case), or (3) as in Satta's case, where the femoral head was fractured at a right angle to the long axis of the neck (*see Fig.* 151,D), on account of the impossibility of maintaining reduction either of the fracture or the luxation.

The longest interval between the injury and the successful reduction of a dislocation, which gave a good result, was twenty days (Nichiarelli's case).

Good results by 'closed' methods have been obtained whether the fragments of the head are displaced outside the acetabulum (Platt and Nichiarelli) or remain within (Christopher).

II. FRACTURE OF THE NECK OF THE FEMUR WITH HIP-LUXATION

Besides our own case (*Case* 2), we have found records of fifteen others in which it is claimed that this association of injuries was caused by ordinary trauma. Two of these sixteen cases, Robert's and Riedel's, have already been dealt with; in Robert's case there was also a separate fracture of the femoral neck, and in Riedel's the oblique fracture of the head ran through to the upper part of the neck (*see Fig.* 151,E). In three of the sixteen cases—Chitwood's, de Chégoin's, and Harcourt's—the records do not clearly establish a diagnosis of femoral fracture with luxation: all three are rejected by Stimson.* Eleven cases out of the sixteen are thus left for study.

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* These three cases have been quoted as authentic by various writers; we therefore summarize them here:—

H. de Chégoin's case, seen in 1868, is reported by Wippermann, who gives the following details: A female, aged 77, was injured by falling from her chair. The case was diagnosed as a fracture of the femoral neck with an unspecified luxation of the hip. The injury was treated by slight extension only. Sixteen months later the great trochanter was found to be displaced upwards and back: there was shortening and eversion of the foot. Five years after the injury she could go up and down stairs: Stimson believes that this was a case of simple fracture of the femoral neck.

In Chitwood's case, a male, aged 45, a diagnosis was made of luxation on to the dorsum

Sex and Age Incidence.—Of these eleven cases seven were male; one was female: in three the sex was not stated. The oldest was either our own case, who did not know his age but looked 70, or Monk's, aged 64; the youngest was the female patient, aged 13. The average age of the eleven patients was 37, five of them were over 50.

The Hip-Luxation with Neck-fracture.—In six cases the luxation was backward, in two pubic, while in one (our own *Case* 2) it was downward and forward; in two cases the variety is not recorded.

Causation.—Great violence in which it is impossible to distinguish separate or successive elements caused four of the eleven fractures of the femoral neck accompanied by hip-luxation—the fall of a building, a fall from a roof, the impact of a tramcar, an automobile, overturned by a train, pinning down the victim. Our own case, on the other hand, merely slipped on the footpath (he thought on banana peel) with his lower limbs apart.

Tunnecliff and Lossen each record the clear succession of two separate traumatic events.† In Tunnecliff's case, where the injury was on the right side, a tree fell on the patient's left shoulder driving his feet through a sheet of ice: his body was inclined to the right, and, as he fell through, the right great trochanter struck hard on the edge of the hole. In Lossen's case a ladder crashed with the patient, who landed on his feet, and then fell sideways, striking the great trochanter of the affected limb against the ladder.

Post's case, a girl of 13, received a blow on the back "with a twisting of the body to the right and the lower extremities to the left". Both hips were luxated and the left femoral neck was fractured. The definite history given in the two cases just quoted, suggests the possibility of an unrecorded fall on the left side in Post's patient.

In the remaining three cases of this series of eleven, the cause of injury is not stated.

Neighbouring Fractures.—In only one case (Buchanan's) was there evidence of a neighbouring fracture: "the outline of the pelvis near the acetabulum was indistinct as though from a fracture" in an X-ray taken five months after the accident.

Local Complications.—In Post's case there was necrosis of the luxated head of the femur. This complication of hip-luxations was first noted by Sir Astley Cooper: "Sometimes, after the reduction of dislocations, suppuration ensues, and the patient falls a victim to excessive discharge and irritation". He quotes two examples with death occurring in a few days. (Two instances of sepsis following 'closed' attempts at reduction will be found in *Part II.*)

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ilii, with a fracture of the femoral neck, which Kammerer believed was only partial. The injury was caused by a fall from a wagon which then unloaded its contents on the patient. The fracture was not diagnosed by Chitwood but by the physician in charge, five days after the luxation had been reduced by manipulation: the fracture was then complete—Kammerer thinks, as a result of the reduction.

In Harcourt's patient, a male, aged 41, the presence of a luxation "probably forward on the pubis" was diagnosed according to Kammerer solely from a snapping noise heard while the case was being examined under anæsthesia.

Stimson characterizes the diagnosis in the last two cases as "wholly untrustworthy".

† Kammerer believes that every case of hip-luxation with femoral fracture is "the result of two distinct violences", and he cites the cases of Tunnecliff and Lossen, adding however Chitwood's, to which we have already referred.

Buchanan's patient suffered from peroneal palsy which is referred to below under the heading 'Treatment'.

Treatment of Neck-fractures with Hip-luxation.—Three of the eleven cases (Haase's, Gärtner's, and Douglas's) received no treatment, the fracture and luxation being found post mortem. In our own case the proximal fragment of the fracture was so completely separated and so far displaced that we thought its reduction imprudent in a frail and aged patient, and we removed it at the operation because its sharp end was thrusting the profunda vessels forward. Post's case was not reduced, and Lossen makes no mention of reduction. The cases where reduction of the dislocation was effected number only four: three, of which one died, were reduced by 'closed' methods and one by open operation.

'Closed' Reduction.—Monks reduced an anterior luxation somewhat like that present in our own *Case* 2, except that the head lay higher and was turned proximally instead of distally: the fractured end of the proximal fragment projected forward, causing venous obstruction and stretching the superficial femoral artery over it. Fearing that this fragment would ultimately open the vein or artery, Monks decided to attempt immediate reduction, and in case of failure to excise the luxated head. Under ether anæsthesia "steady traction was made by an assistant while an attempt was made to manipulate the bone back into the joint. This was successful, but only after a prolonged trial during which the leg was placed in a variety of positions." The patient died seven hours after admission: he had, in addition to his femoral fracture and luxation, a fracture of the clavicle and of four ribs in the cardiac area.

Tunnecliff records (1868) one of the two cases of 'closed' reduction that survived in this group. The patient was left for thirty-eight days until there should be a measure of bony union in the fracture.* The sciatic lesion was then reduced by flexion and abduction of the thigh, with direct pressure on the femoral head. As the head crossed the acetabular rim the neck of the bone was re-fractured. A long external splint was applied to the limb and extension made through a foot-piece, with counter-extension from the perineum. Five weeks later the patient could walk with one crutch, and afterwards progressed favourably with only $\frac{1}{2}$ in. of shortening.

Hoeftmann records (1904) the second case of survival in this group after reduction by a 'closed' method. His patient was a male with posterior luxation of the hip and a fracture of the femoral neck, both on the right side: the patient's age is not stated. Many attempts at reduction failed, and ten weeks after the accident, a fall from a roof, X-ray examination showed that the head of the femur had united almost exactly at the *back* of the femoral neck. The limb was markedly rotated inwards and was adducted. When the posterior fixation of the head was realized "the reduction was child's play"; the limb was rotated outwards till the foot pointed backwards, when the femoral head at once slipped into the acetabulum.

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* Tunnecliff, who saw his case a month after it had been diagnosed by Drs. Woodworth and Lord, writes: "I must confess that I had at first some doubt about the alleged fracture, but Drs. W. and L. both assured me most earnestly that they could not be mistaken on this point, as both had felt distinct crepitations on their first visit, and then the great mobility of the limb at that time would seem to confirm the view. I observed further that pressure upon the neck of the bone at the base of the great trochanter elicited evidence of tenderness at that point, and I was forced to acquiesce in the views of the attending physicians."

The foot, however, still pointed back after the reduction was effected. The femur therefore was sawn through just below the trochanters in order to correct this deformity.

Operative Reduction.—The only operative success in this group belongs to Buchanan, of Pittsburgh. He first saw his patient, when the fracture was already united, five months after the accident. Prolonged extension was disappointing, and the case was treated by open operation some seven months after the original injury. The acetabulum was exposed through Kocher's incision: it was filled with dense connective tissue, which was dissected out, exposing the normal cartilage. Traction was applied through adhesive plaster strips attached to the flexed thigh, by means of a strap passing round the shoulder of an assistant and hooked at its ends into rings attached to the plaster strips. The lifting effect of the shoulder-traction was supplemented by the assistant hooking his elbow under the patient's knee, standing, as he did so, on a stool. Four levers were then passed under the femoral neck, and by combining manipulation with traction the head was reduced. The patient recovered from the shock of the operation and from reactionary oozing that occurred later in the day. The limb was splinted in abduction, and extension was applied to the other limb " to keep the pelvis from tilting towards the injured side ". After operation, foot-drop was noticed, which persisted for several months, but finally disappeared; it was thought to be due either to pressure on the sciatic nerve by the levers, or more probably to the traction exerted on the external popliteal at the bend of the knee.

A case reported by C. E. Thomson, though it does not belong to *Part I*, since the fracture was caused by surgical intervention, bears on the operative treatment of this condition. The femoral neck was broken in an unsuccessful attempt to reduce an unspecified luxation of the hip of eight months' duration in a male whose age is not stated. Ten days after this surgical accident the luxation was reduced by open operation: anterior and posterior incisions were made, and the femoral head was replaced by traction with blunt hooks. Reduction of the fractured neck was maintained by means of a specially devised nail, and the author concludes his account with the hope that the patient will have a " useful stump ". (The leg on the side of the fracture and luxation had been amputated five weeks after the original accident.)

Results.—Only three good results have been definitely recorded in neck-fractures with luxation—Tunnecliff's (1868), and Hoeftmann's (1904), treated by ' closed ' methods thirty-eight days and seventy days respectively after the injury, and Buchanan's (1920) by open operation seven months after the injury.

Results in Cases Successfully Reduced.—Tunnecliff's case could walk with one crutch five weeks after reduction; the subsequent progress was favourable, and the shortening amounted only to $\frac{1}{2}$ in. In Hoeftmann's case the result is recorded as ' satisfactory '. Buchanan's patient was fitted with a brace seven weeks after operation, and a week later walked with it in the ward, still showing signs of a partial peroneal paralysis. Five and a half months after the operation, when he discarded the brace, there was no shortening but some eversion, which was attributed to the destruction of the internal limb of the Y-shaped ligament. Six and a half months after operation the peroneal palsy had disappeared and he walked with comfort; shortening of from $\frac{1}{2}$ to $\frac{3}{4}$ in. was now evident, and eleven months after operation this had increased to $1\frac{1}{8}$ in. He then walked

" with a solid gait and without pain and has for some months been working as an automobile repair man ".*

Monks' case with multiple injuries who died a few hours after a ' closed ' reduction has been referred to on p. 214.

Results in Unreduced Cases.—In Post's case the proximal fragment was excised for necrosis causing a sinus six months after the accident; there was a final shortening of 4½ in. (The other hip, which had also been dislocated in this patient, was successfully reduced with full restoration of function in that hip.) The result is not mentioned in Lossen's unreduced case, while the cases of Douglas, Haase, and Gärtner were investigated post mortem.

Our own *Case* 2, after excision of the proximal fragment and insertion of the remainder of the neck into the acetabulum, insisted on leaving hospital while in full abduction in a plaster-casing which he broke to pieces in a few days. He was seen later, wearing fragments of the casing, with 4 in. of shortening, but he refused all further treatment.

Comment.—It will be noted first that in the three cases where good results were obtained (Tunnecliff's, Hoeftman's, and Buchanan's) union of the fractured femoral neck had occurred before the hip-luxation was reduced. Kammerer, in some experiments on the cadaver which are relevant to this point, found that, if the *shaft* of the femur were broken, he was able to reduce a coexisting luxation of the hip by grasping the end of the proximal fragment with lion-forceps through an incision, and manipulating the head through the skin. Fracture of the *neck*, on the other hand, prevented him from reducing the luxation. We have since found that Richet anticipated Kammerer's experiments in 1853. Richet, unlike Kammerer, easily reduced luxations of the hip associated with neck-fracture in the cadaver simply by pushing the head back into place.

These results, in apparent contradiction, led us to repeat the experiments. Our attempts were confined to posterior luxations with fracture. If the proximal fragment was large, as in shaft-fracture or *distal* fracture of the neck, we could easily reduce the luxation by direct pressure applied to the femoral head, with the subject prone in the Stimson position—the lower limbs hanging over the table at right angles to the trunk. If, however, the fracture was subcapital and the proximal fragment was small, we could not reduce it. By passing a finger through a stab-wound we found that failure was due to the difficulty of guiding a small fragment, which slipped and turned turtle, back through the collapsing tunnel torn in the soft tissues by the luxation. We think that our experiments perhaps explain the discrepancy between those of Richet and Kammerer.

In Thomson's case, quoted above, of surgical fracture with a hip-luxation eight months old, operative reduction was accomplished and the result promised well, though the fracture had not previously united.

One problem for the surgeon, then, is whether (1) to wait for union of the fractured neck before attempting to reduce the luxation, or, (2) to operate early, before union has occurred, while the luxation is still recent. Decision is less difficult in cases like our own, where the proximal luxated fragment is so widely divorced from the rest of the femoral neck that it would be impossible to reduce

* We were not able to ascertain whether De Morgan reduced the luxation in his case or not; if he did, he used a ' closed ' method. The patient walked with a stick twelve weeks after the injury and returned to work.

it, and where (as in Monks' case and in ours) the proximal fragment is a danger to important vessels. Dangerous fragments must be removed, and the opportunity will then be taken of thrusting the distal part of the neck into the acetabulum—elongating the neck in case of need by Whitman's method of detaching the great trochanter and re-affixing it lower down the shaft.

It is unlikely, in older patients, whose uncomplicated fractures of the femoral neck so often fail to unite, that the chance of union will be increased by cutting down to reduce the luxation, *unless the fragments can be artificially impacted.*

In younger patients suffering from grave additional injuries, who by the time their dislocation is ' old ' have recovered sufficiently to undergo operative reduction, the interval of waiting must be employed in securing proper union of the fracture. The fragments should be adjusted under radiographic control, for, as Kammerer first pointed out, mal-union of the neck may be such that when the luxation is reduced the patient is crippled by eversion of the limb—a fact strikingly exemplified in Hoeftmann's case, where ten weeks after the accident the proximal fragment bearing the femoral head had become united to the *back* of the neck. It will be recalled that after the luxation had been reduced Hoeftmann was obliged to divide the femoral shaft to correct backward pointing of the foot.

Suggested Plan of Treatment in Neck-fractures with Hip-luxation.—The treatment of fractures of the femoral neck is often difficult when they are uncomplicated, and it would be premature—on a basis of only three good results—to do more than sketch a provisional plan for treating them when complicated by luxation. Certain eventualities are here put forward, and the treatment of each is suggested.

1. *The Proximal Fragment Endangers the Main Vessels.*—Operate at once to free the vessels, dealing with the proximal fragment according to the circumstances specified in the following paragraphs.

2. *The Proximal Fragment is merely Divorced from the Rest of the Femoral Neck.*—

a. In *the aged*, but apparently robust, where useful union is unlikely, the fragment may be left alone and an attempt made to thrust the rest of the neck into the acetabulum, and to maintain it there by fixing the limb in abduction and inversion. The neck may be lengthened in case of need by detaching the trochanter major and re-affixing it lower down the shaft.

b. In *younger patients*, open operation will give an opportunity of replacing a completely separated head. We think that Cotton's method of artificially impacting the two fragments by mallet blows on the great trochanter may then sometimes solve the problem of union. (One of us (M. B.) has used artificial impaction of the femoral neck with success in an open wound.) We feel, too, with Cotton, that to peg-graft a head which has been so completely separate is to place undue reliance on the union of two devascularized pieces of bone.

3. *In Patients Suffering from Other Grave Injuries—of Abdomen, Chest, or Skull (' Poor Risks ').*—

a. Those who recover as ' good risks ' : Fix the fracture in good position and reduce the luxation either by a ' closed ' method or by open operation after bony union has occurred, remembering that Tunnecliff reduced a luxation successfully on the thirty-eighth day by manipulation, and Buchanan by open operation after seven months.

b. Those who continue as 'poor risks': Fix the fracture in good position and compensate the inevitable shortening by a suitable prothesis.

4. *Neglected Cases where Bony Union of the Fracture has Occurred.*—

a. In good position (as regards the relation of the head and neck).—These should be treated, when possible, by open reduction. (Buchanan's case is an encouraging example.)

b. In bad position, so that after reduction there will be, perhaps, a disabling or disfiguring eversion of the limb. These cases may require osteotomy of the femur—usually of the shaft (as in Hoeftmann's case)—and re-adjustment, *after* the luxation has been reduced. Softening or deformity of a head long luxated may, however, call for resection and implantation of the neck into the acetabulum.*

5. *Neglected Cases without Union of the Fractured Neck.*—Must be operated on in 'good risks' whenever possible, reducing the luxation and impacting the fracture, or, where this cannot be done, implanting the neck into the acetabulum. In 'poor risks' the treatment will be as in paragraph 3 (*b*) above.

III. FRACTURE OF THE SHAFT OF THE FEMUR WITH HIP-LUXATION

In addition to our own *Case* 1, we have collected fifteen records of this injury from the literature.†

Sex and Age Incidence.—Only two of these sixteen patients were female. The age incidence is somewhat remarkable—8, 9, 9, 12, 13, 13, 14, 16, 19, 24, 38, 40, 51, 64, 'adult' (the age in one case is not stated). Thus more than half the cases are under 20, the average age being 21. Our own case, aged 64, is the oldest of the series.

The Luxation of the Hip-joint.—This was reported either as 'posterior', 'dorsal', or 'upon the dorsum ilii' in eight cases (*see* footnote on these terms, p. 208). In two cases it was stated to be sciatic; in one, downward and backward between the acetabulum and the ischial tuberosity. Pubic luxation occurred in two cases, suprapubic in one, and obturator in two. There does not appear to be any significant association between a particular type of luxation and the level of the fracture in the shaft.

The Fracture of the Femoral Shaft.—The level of this fracture is recorded in fourteen cases; in all but two it lay either in or above the middle third of the bone: thus one fracture was in the lower third and one at the junction of the lower and middle third, while four were in the middle third, four at the junction of the middle and upper thirds, two were in the upper third itself, and two were subtrochanteric. In Delagarde's case the shaft was fractured in two unspecified places.

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* An unintentional fracture of the femoral neck has re-united (Tunnecliff's case), but re-fracture of the *neck* is not to be recommended unless the head-fragment has become fixed in a position that makes it impossible to reduce the hip-luxation.

† Unless we include the case that Markoë reported in 1855. This patient, a boy, aged 8, fell from a high ladder and was believed to have a posterior luxation of the right hip, with compound fracture of the right femoral shaft. The case was seen and treated by Markoë's resident medical officer. The right foot was stated to lie in the left axilla: the limb was brought back across the abdomen and was adducted and lowered to the bed. Reduction of the luxation is said to have occurred during this manœuvre. There was also a simple fracture of the left thigh. Hamilton was not convinced by this account, The case was reported as cured.

Causation.—We have already spoken of Kammerer's belief that the association of any femoral fracture with hip-luxation is always the result of at least two separate traumatic events, but in most of the cases in this group it is easier to suspect than to distinguish them. In seven of these sixteen cases with shaft-fracture, the injuries were due to gross violence in which it is impossible to find either sequence or distribution—the fall of coal, of a wall, of chalk in a chalk-pit, of a tree; a crush by a cart-wheel; impact with a tramcar. Allis's case, though struck by a moving railway-car, was hit only on the shoulder; no other detail is given of the accident. Bainbrigge's patient, a woman aged 38, and an invalid for two years, was standing with her left hand on a table, her right on a cane. Losing her balance, the weight of her body was thrown on the left leg, on which she made a semi-revolution and then fell to the ground. O'Connor's patient fell from a height of ten feet to a beam which passed between his legs; he then fell fourteen more feet to the ground. Kammerer gives a very full history of the case in his boy-patient, aged 13, but we are unable to share his confidence in assessing separate causes for the fracture and luxation, since he states that the boy felt no pain when he was first thrown backwards from a swing that carried six children, nor yet while he was trying to escape from its path: the swing, however, on its return, struck the thigh so heavily at the site of fracture that the boy fainted. The right foot of Cook's patient slipped into a hole, and he fell with his legs wide apart. When trying to rise with his foot still caught, he fell again, on his right side. Murdoch's patient fell between railway trucks, and was struck by the brake-rods as two cars passed over him. In Fergusson's case and in Birkett's the cause is not stated.

FIG. 152.—Illustration of the way in which crushing loads may produce hip-luxation. The flexion, adduction, and rotation inwards may here luxate the *right* hip. A fall or impact may then break the right femur. This combined mechanism is relevant to certain cases described in the text. (*Re-drawn from Cotton.*)

The cause in G. R. Harris's case was peculiar: D. H., a boy aged 9, was running over heavily crusted snow, when he broke through and fell forward. Another boy, who was running after him, fell on top of him. The patient was unable to arise and was carried home. (In this case the luxation was into the obturator foramen, and the shaft broke at the junction of the middle and upper thirds.)

Thus in seven cases there is a record of great and indiscriminable violence. In six there is a suggestion of two events, a wrench and a fall in Allis's*

* It is possible that the causation in our own case resembles that in Allis's patient—a wrench due to the tram's impact and a fall on the street, but we could get no clear history from the patient.

(*Fig.* 152) and Bainbrigge's cases; forced abduction and secondary falls in those of Cooke and O'Connor, and a primary fall with a secondary impulse in Harris's case, and possibly, too, in Murdoch's.

Treatment and Results of Shaft-fracture with Hip-luxation.—In eight of the sixteen cases the luxation was reduced. No attempt at reducing the luxation was made in four of the seven cases in which it was not reduced, though in each the fracture was treated. The dorsal luxation was not diagnosed in Allis's patient for fourteen weeks (1879), and in Bainbrigge's (1846) for five months, after the accident. Murdoch (1878) found a posterior luxation in his case post mortem. Kammerer (1889) comments as follows on the pubic luxation which he first saw ten months after the injury: "A reduction of the dislocation would, I fancy, cause an inward rotation of the lower limb of about 45°, and would certainly greatly impair its usefulness, unless the bones were refractured and set in a correct manner. And I think that no valid objection could be raised to such measures. . . . In my own case, then, it is only the impossibility of reduction which has prevented the attempt. When I saw the patient the dislocation was of ten months' standing."

It should be observed that the most recent of these abstentions from reduction was recorded as far back as the year 1889. In one case, Thornhill's, the fact of reduction is doubtful.

Failures.—In three cases reduction was attempted and failed. Delagarde's case of sciatic luxation with double fracture of the femoral shaft was of five months' standing when first seen. The fracture had united, and he excised the unreduced head: the patient is described as 'relieved'. In Fergusson's patient (posterior luxation and fracture of lower third of shaft) the luxation was not detected "for some considerable time"; the shaft had united. In Forster's case (dorsal luxation and fracture of middle third of shaft) the luxation was not reduced.

Successful Reductions of the Luxation with Shaft-fracture.—These were obtained in eight of the cases in this group: seven were effected by 'closed' methods, one by open operation; no case died.

Sir Astley Cooper, in 1823, recorded the first successful treatment of the condition "hip-luxation with ipsilateral fracture of the femur" in a case belonging to this group with shaft-fracture: "The hip was dislocated on the dorsum and the same thigh broken about the middle of the bone. As the reduction of the hip was, of course, impracticable, the thigh was bound up in the usual manner and treated without any reference to the dislocation of the joint, with the hope that, when the thigh-bone was reunited, the hip might possibly be reduced. At the end of five weeks, the bone appearing tolerably firm, I had a very careful and unremitting extension made by pulleys, and in less than half an hour had the satisfaction of feeling the head of the bone re-enter the socket. . . . The patient became so upright as to show scarcely any signs of lameness afterwards."

The pubic luxation in Bloxham's patient, aged 14, was also reduced by pulley-traction, but before the shaft had united. The fracture here was just above the middle third. When a week's immobilization in short splints had reduced the swelling, the entire limb was fixed in long splints: the pelvis was fastened to the table, traction was then applied from a pulley fixed to the ceiling one foot to the right of a point vertically above the patient's navel. Reduction here too occurred in thirty minutes under the resultant of (1) the vertical pull, (2) the pull of the gluteal muscles, and (3) direct manipulation of the femoral head. Passive

movements were begun eight days after reduction, and eight months later the patient had ½ in. of shortening with full function.

Two cases, Etève's (posterior luxation and fracture of middle third of shaft), and Cooke's (obturator luxation and subtrochanteric fracture), aged 8 and 9 respectively, were reduced, one day and "at once" after injury, by direct pressure on the femoral head, supplemented in Etève's case by hip-flexion to 90°. The result in Etève's case is not stated by Malgaigne, who quotes it, but Cooke's patient, treated on a double-inclined plane for fifteen days after reduction, and then with a long external splint, had no shortening and limped only a very little. There was, however, a good deal of thickening at the site of fracture.

O'Connor's case (dorsal luxation and fracture of junction of upper and middle third of shaft) is remarkable in that the traction which reduced the fracture is said to have reduced the luxation at the same time, owing, it was thought, to spasm of the vasti. Neither the patient's age nor the interval between injury and reduction is stated: the man recovered with a ½ in. of shortening.

Bryant states that in 1860 he saw Birkett reduce a pubic luxation associated with subtrochanteric fracture in a boy aged 12 "by gentle well-directed movements"; no further details are given.

G. R. Harris, who most kindly sent us details of his case, reduced an obturator luxation associated with shaft-fracture at the junction of the middle and upper thirds in a boy aged 9. Making the father fix the pelvis, Harris grasped the femur above and below the fracture, and reduced the luxation by rotation and extension. The after-treatment was by extension with strapping and a weight of 10 lb., while the thigh was fixed between sand-bags. The boy was up and on crutches in four weeks; three weeks later there was a ½ in. of shortening, and in six weeks after the accident he was climbing trees.

Our own *Case* 1 (female, aged 64: luxation on dorsum ilii and fracture of upper third of shaft) is the only one in this series whose luxation was reduced by open operation. The method of reduction, three weeks after the accident, has been sufficiently described in the introduction to this study.

Comment.—Except in Murdoch's patient, who died a year after the injury, from an operation on the *fracture*, and in whom the luxation was found post mortem, there were no deaths in this group of sixteen cases. The age of six of the seven cases with luxations reduced by 'closed' methods was between 9 and 16 years; the seventh case (O'Connor's) is described as 'adult'. The interval between the accident and reduction in four of these seven cases was short, varying from 'immediate reduction' to reduction after eight days. Only in one case (Sir Astley Cooper's) had the fracture united prior to successful reduction of the luxation, union occurring in a five-week interval after the accident. The intervals in Birkett's and in O'Connor's cases are not mentioned.

Ease of reduction is definitely related to weakness of musculature, a fact noted by Richard Wiseman, Serjeant-Chirurgeon to Charles II, in 1676. This probably accounts in some measure for the successful cases in this group where so many of the patients are children.

The cases in which reduction either was not tried or failed when attempted were all 'old' luxations, fourteen weeks being the shortest interval recorded between the accident and the recognition of an 'old' luxation or the attempt to reduce it.

In our own case resort was made to operation three weeks after the accident, when two attempts at 'closed' reduction had already failed.

Suggestions regarding Treatment of Shaft-fractures with Hip-luxations.—The successful cases quoted above encourage a trial of 'closed' methods at the earliest possible moment, splinting the fracture, and treating the luxation by direct pressure on the femoral head. Our own experiments on the cadaver lead us to think that in the case of *posterior* luxations this pressure can be applied with most effect and with least fatigue when the patient is in the Stimson position, lying prone with his limbs hanging vertically over the end of the table. When the luxation is *pubic*, pressure can be applied when the patient lies on his back. The muscular relaxation obtained by spinal anæsthesia should greatly facilitate reduction under these conditions.

Even in cases of some standing the surgeon may take heart from the fact that Sir Astley Cooper, in a boy of 16, reduced "in less than half an hour" a luxation on to the dorsum ilii with pulleys after five weeks, when the fracture at the middle third had united.

Operative Reduction of Shaft-fractures with Hip-luxation.—Our own case showed us that excellent exposure both of the luxation and the fracture can be got by the well-known Smith-Petersen approach combined with the anterior exposure of the femoral shaft to which we have already referred. The proximal fragment might be manipulated with a special fracture-hook, or, as in our case, with a strong wire transfixing the bone and twisted into a wide ring for comfortable traction. With this incision the femoral head can easily be controlled and levered into the acetabulum.

Hey Groves has pointed out that in difficult cases of old-standing congenital luxations of the hip, open reduction may become easy after dividing the femoral shaft near its upper third, a step which eliminates the pull of many muscles that oppose the descent of a proximally displaced head. Hey Groves thus confirms on the living the experiment performed in the dead by Kammerer some fifty years back.

Cases of Shaft-fracture with Luxations Long Unreduced.—The femoral head in these patients may be so deformed by pressure that it cannot be usefully replaced; it must then be resected in those fit for operation, implanting the neck into the acetabulum after lengthening it in case of need by Whitman's method.

Cases that are Irreducible.—Finally there are those cases in which from any cause reduction of the luxation is impossible, or is contra-indicated. The fracture none the less should receive most thorough treatment. As a rule there is a progression of the immediate shortening, and in only one case (Kammerer's) is a patient with his luxation unreduced reported as having satisfactory function. This boy, though unable to move his hip-joint, "could walk and run . . . very little hindered in the activities of life". The majority of these patients, however, despite the formation of new sockets for the head, will be rendered unfit, like Fergusson's case, for "active pedestrianism".

IV. FRACTURES OF THE FEMUR OTHER THAN OF THE SHAFT, NECK, OR HEAD, WITH HIP-LUXATION

We have found only three undoubted cases belonging to this category. Borchard saw a boy, aged 14, in whom suprapubic luxation of the hip was accompanied by a *fracture of the great trochanter*, and mentions a similar case seen by

Lauenstein. The injury in Borchard's case was due to a fall under a roller drawn by a runaway horse. The tibia and fibula were also fractured, and the patient died soon after admission to hospital.*

Drehmann, in 1896, reported a case of von Mikulicz, with a left dorsal hip-luxation and an *epiphysial separation* of the left femoral head: the boy, aged 8, fell to the ground while carrying another boy on his back. Immediate efforts at reduction failed. After fourteen days in bed the boy came limping to hospital on the toes of his left foot with the knee and hip bent. All hip movements were limited. The femoral head was felt posteriorly, close to the great trochanter, when the thigh was moved. There was 4 cm. of shortening. A further unsuccessful attempt at 'closed' reduction was made in hospital, ten weeks after injury. Von Mikulicz then separated the great trochanter through a transverse incision and evacuated the acetabulum. The epiphysial separation which makes the case unique was found during operation. The epiphysis was displaced posteriorly and outwards. Though union is not mentioned, the fragment had probably united with the neck in the ten-week interval before the operation, since (1) the position of the head was first recognized by moving the thigh, and (2) some degree of external rotation persisted in spite of attempts at correction. Von Mikulicz reduced the dorsal luxation by manipulation, and sutured the trochanter back into place, splinting the limb in extension and outward rotation. The wound healed by first intention, and the patient walked with a stick in six weeks, leaving hospital three months after operation. This case is probably comparable with that of neck-fracture with luxation, recorded by Hoeftmann (*see above*), where the posterior fixation of the proximal fragment caused extreme eversion of the limb after reduction, which was only corrected by dividing the femoral shaft.

SUMMARY OF THE GROUPS OF FEMORAL FRACTURE WITH HIP-LUXATION DUE TO ORDINARY TRAUMA

We can now compare certain features of the various categories. The number of cases in each group is too small to establish etiological factors of decisive value, but certain points are suggestive.

Age.—Fractures of the *shaft* with luxation, claim the six youngest patients, (8, 9, 9, 12, 13, and 14 years), and this group is the only one in which more than half the recorded cases are under 20, the average age in the group being 21. Among the femoral *neck* and *head* fractures, only three cases, and one case, respectively, are under 20 years, the average age in each of these two groups being 37 and $38\frac{9}{12}$.

Sex.—Only eight females have been found with femoral fracture and hip-luxation (eight out of forty-two authentic cases).† Five of them occurred in the

* A case of hip-luxation with fracture described by Monks in a man aged 60 is omitted as Monks is doubtful whether the fracture was of the great trochanter or of the acetabulum

† Gaub's case (1917) which was communicated privately to Buchanan, who quotes it (loc. cit, Case 49, p. 147), is not included: it has been impossible to classify as we were unable to learn the site of the femoral fracture. The patient, a male aged 35, was rolled between railway cars, sustaining an 'anterior' luxation of the hip, which was overlooked for three months in the presence of other injuries. After clearing the acetabulum Gaub reduced the luxation through an anterior incision by means of levers and traction, and applied a plaster case extending to the nipples. The functional result was excellent, the patient now working as a conductor. It is not stated whether the femoral fracture had united before the reduction.

group of thirteen patients with fracture of the femoral head. Only one female suffered from fracture of the femoral neck, and two from shaft-fracture.

Relations of the Variety of Fracture to the Variety of Luxation.—The following table, modified from Kammerer's, shows this relationship :—

		Fracture of Head	Fracture of Neck	Fracture of Shaft	Other Femoral Fractures	Totals
Luxation backward (30 cases = 75 per cent)	Described as 'dorsal', 'posterior', or 'upon dorsum ilii' ..	12	4	8	1	25
	Into sciatic notch ..	1	1	2	–	4
	On to ischial spine ..	–	1	–	–	1
Luxation downward (4 cases = 10 per cent)	Behind lip of acetabulum	–	–	1	–	1
	Into obturator foramen	–	–	2	–	2
	Down and forward into Scarpa's triangle ..	–	1	–	–	1
Luxation forward and up (6 cases = 15 per cent)	Pubic	–	2	2	–	4
	Suprapubic	–	–	1	1	2
		13	9	16	2	40*

* In two cases, both with neck-fracture, of the forty-two cases reckoned as authentic, the variety of hip-luxation is not specified.

Injury Causing the Luxation and Fracture.—Fractures of the femoral *head* appear to have been associated with the greatest violence—sufficient in four cases to cause early death : only one case in this group was due to relatively slight trauma. The possibility of the luxation and the fracture being "the result of two distinct violences", as Kammerer believed, has been fully discussed under the headings of neck- and shaft-fractures.

Symptomatology.—This has been dealt with above only in the group with head-fractures, where it has been treated as fully as the records permit. In the other groups information on this point is scanty. It is best summarized in the words which Stimson adapts from Koch : "When the two injuries (femoral fracture and hip-luxation) have coexisted the diagnosis has sometimes been made by recognizing that the head, which could be felt out of its place, did not share in the movements communicated to the shaft."

Results of Treatment.—In the series of forty-two authentic cases the hip-luxation was reduced in twenty-two patients, in sixteen by 'closed' methods with eleven good results ; in six by operation with four good results. (Thornhill's doubtful 'closed' reduction is not included, and in one case of 'closed' reduction the result is not stated.) In fifteen cases, therefore, the functional result was good* after reduction, while in six cases where reduction was effected the result was disappointing. Thus three patients died after 'closed' reductions. One case

* 'Good', that is, as regards the hip ; three of these cases were complicated by sciatic lesions, one of which admittedly followed operative reduction, and this was the only one which had recovered when the cases were reported.

of ankylosis occurred after operation, and one after 'closed' reduction. In one case the luxation recurred after a first operation and sepsis followed the second arthrotomy.

The worst results were obtained when the femoral *neck* was fractured; four luxations were reduced out of ten cases. Of these, three were reduced by 'closed' methods (one patient dying soon after of multiple injuries); one was reduced by operation. In the three surviving cases the fracture had first been allowed to unite, so that the femoral lever was re-established. Drehmann, in the equivalent condition of epiphysial separation of the femoral head, obtained a good result by operative reduction ten weeks after the accident; union of the fracture had probably occurred.

The want of success in this group is repeated in *Part II*, where the femoral neck-fracture was caused by attempts to reduce a luxated hip, and here we find a satisfactory final result in only one case out of seventeen.

More luxations were reduced in association with fracture of the femoral head than with any other fracture. This is natural since the femoral lever in this fracture remains unbroken, unless the fracture is transverse to the long axis of the neck. Thus, reduction was effected in nine out of thirteen cases with head-fracture: two, however, died soon after. Among the patients that survived, four good results were obtained—three by 'closed' methods, one by operation.

With fracture of the shaft, eight reductions were obtained out of sixteen cases—seven by 'closed' methods, one by operation. The result after reduction in seven of these patients was good; in one case it is not recorded.

It would appear then that if a patient sustains fracture of the shaft with hip-luxation, or survives the force that breaks the femoral head, a good result may sometimes be got by making early trial of 'closed' reduction. 'Closed' methods are likely to fail when the femoral lever is broken—as in fractures of the neck—by transverse fracture of the femoral head.

Note A: On Union of the Fracture before Reduction of the Hip-luxation.—Astley Cooper believed that reduction was 'impracticable' apart from union. Actually union had occurred in only five of the twenty-two cases where reduction was obtained, one of these five being treated by operation. Thus seventeen luxations out of the twenty-two were reduced before the associated femoral fracture had united—twelve by 'closed' methods with six good results; five by operation with three good results.

Note B: On the Interval between the Accident and Reduction of the Luxation.—With *head*-fractures the only long interval was three months, occurring in a case ending in ankylosis, where the luxation was reduced by operation. In one case treated by 'closed' reduction the interval was three weeks, and here it was thought that the fracture had partially united. Six other luxations were reduced by 'closed' methods with a maximum interval of five days; one of these recurred on the nineteenth day.

Relatively long intervals are found in the only three successful cases with *neck*-fractures—thirty-eight days and ten weeks in the two cases reduced by 'closed' methods; seven months in the case reduced by operation. In all three the fractured neck had united before reduction was tried.

In two *shaft*-fractures there were intervals respectively of three weeks before 'open', and of five weeks before 'closed', reductions, while in the remaining four

cases where the interval is mentioned the luxation was reduced by ' closed ' methods within five days. (Cooper's case, with a five-week interval, was the only one in which the shaft-fracture had united).

In cases where attempts at reduction failed the interval is recorded in only two, one of head-fracture (three months), one of shaft-fracture (five months); in both the femoral head was resected: death followed immediately in the first case.

PART II

'SURGICAL' FRACTURES OF THE FEMUR CAUSED BY ATTEMPTS AT REDUCING LUXATIONS OF THE HIP

The accident of fracturing the femur during an attempt to reduce a luxation of the hip confronts the surgeon with one or other of the conditions already reviewed in this paper. We can therefore consider briefly, under three headings, twenty-one reported cases of a mishap which has severally affected the *head*, the *neck*, and the *shaft* of the femur. Of these twenty-one cases, one fracture was of the femoral head, seventeen were of the femoral neck, and three were of the shaft.*

I. 'SURGICAL' FRACTURE OF THE FEMORAL HEAD WITH HIP-LUXATION

While this paper was under revision, we found what appears to be the only recorded example of this complication, in an article on old traumatic dislocation of the hip. Miltner and Wan report the case of a Chinese male, aged 36, whom they saw first on July 1, 1925. Four and a half months previously he had fallen from a wagon, dislocating his right hip. An X-ray showed that the head was totally displaced through the posterior part of the obturator foramen. A layer of dense material covered most of the surface of the dislocated head, and it appeared to consist of calcified ligamentous and periosteal tissue; it is seen in the X-ray published by these authors to constitute " an imitation of the primary acetabulum ". The inferior rim of the true acetabulum was also fractured, but the femoral head seemed intact except for a moderate amount of osteoporosis. Nine days after admission ' closed ' reduction was performed under ether. During the manipulations, which lasted an hour, and were " very severe ", a cracking sound was heard; following this the head slipped into the acetabulum. An X-ray was at once taken, which showed that the reduction had been obtained at the expense of a fracture through the head. " Several broken fragments of the head remained in the obturator foramen." After the trauma of reduction a large hæmatoma appeared in the

* The two cases described respectively by Physick, and Harris and Randolph, and quoted by Hamilton from Gibson, in which femoral fracture occurred during attempted reduction, are not included, since we have been unable to find what part of the femur was broken. In Harris and Randolph's case, a boy aged 12, with an unspecified hip-luxation, the bone fractured during extension and counter-extension, at the moment of rotating the leg and drawing it forcibly outward with a towel. In Physick's case the fracture was caused in much the same way by force exerted in a lateral direction with an additional pulley. We could get no further detail.

right groin with a rise of temperature between 38° and 39° C. Two weeks later baking, massage, and active and passive movements were begun. Two months later the patient walked on his right leg, but still complained of pain. He had then 60° of flexion, though motion in other directions was greatly limited. One year later the right hip was painful on weight-bearing, but nevertheless was greatly improved when compared with its previous condition.

II. 'SURGICAL' FRACTURE OF THE FEMORAL NECK WITH HIP-LUXATION

Seventeen instances of this fracture are recorded.*

Sex and Age Incidence.—Twelve of the seventeen cases were males, two were females; in three the sex is not stated. The age is specified in twelve cases, and one patient is described as "middle-aged". The youngest was 15, the oldest 82; the average age is 46—a higher average than occurs in any other group of femoral fracture with hip-luxation.

Interval between the Original Accident and the Attempted Reduction.—This interval is recorded in eleven cases; it varies from twenty-four days to one year, the average interval being four months.

The Luxation and the Neck-fracture.—The *luxation* is specified in eleven cases; in eight it was posterior, including three luxations described as sciatic. One obturator luxation is recorded, one pubic, and one anterior and upwards. This last, described by Verneuil, was found post mortem four years after the fracture of the femoral neck in a man aged 82; the head lay in the notch between the ilio-pectineal eminence and the anterior inferior spinous process.

Precise descriptions of the *fracture* are rare; in three cases it was said to be close to the femoral head, and this was its probable site in the cases where the exact position is not specified.

Manipulations which Caused the Neck-fracture.—These are specified in eight cases, and are described respectively as follows (Note: except in three cases—specified in brackets—the luxations were all of the *posterior* variety): flexion; flexion with circumduction; abduction; abduction with inward rotation (*anterior and upward luxation*); abduction with manual traction (*obturator luxation*); pulley traction with "slight rotation"; external rotation: in one case blame is laid on "rotation" alone. (In one other case, Lisfranc's *pubic luxation*, the force is merely described as "great".)

Treatment and Results of 'Surgical' Fracture of the Femoral Neck.—Most of the authors who admit this accident end their record at the point of fracture. In only five cases out of seventeen—Thomson's, Albert's, Bryck's, the case quoted by Wippermann, and Wippermann's own case—have we found indications of what happened afterwards. Thomson's reduction of an unspecified luxation with 'surgical' neck-fracture has already been fully described in *Part I* with the

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* We have included Lisfranc's case with pubic luxation in this group of 'surgical' fractures. Lisfranc himself believed that the fracture was due to the original injury, but his own account of the case suggests instead that it was caused by surgical intervention. The right lower limb was shortened with the foot everted and the great trochanter raised. The thigh was in a position of extension. Flexion and inward rotation were impossible. Reduction was tried by traction with great force: a sudden crack was heard, and signs of fracture of the femoral neck were found.

cases due to ordinary trauma, in order to supplement the meagre information regarding their treatment. It is sufficient here to recall that the luxation was reduced with long hooks through anterior and posterior incisions. In no other case where fracture of the femoral neck was caused solely by attempting to reduce a hip-luxation could we find that the luxation had been afterwards reduced,* though in the case quoted by Wippermann the patient is said to have walked well. Albert states that in his case, where the femoral neck was fractured in the attempt to reduce a posterior luxation, the patient, who had previously walked with crutches, now used a stick only. Bryck and Wippermann, describing the end-results of their own cases, mention the only complication that we could find in this group: in both, an abscess formed round the separated proximal fragment and the necrotic head was removed. Wippermann's patient first walked with crutches and a stick; later she was provided with a high-heeled shoe, but she could not use it. Bryck's patient came to his clinic eight months after the accident; the necrosed fragment was removed; the patient died of erysipelas twenty-one days after the operation.

The reader is referred for information on the treatment of these misfortunes to what we have written above concerning the kindred cases due to ordinary trauma (*see* pp. 217, 218).

III. 'SURGICAL' FRACTURE OF THE FEMORAL SHAFT WITH HIP-LUXATION

We have found only three cases of this rare accident; they are severally recorded by Streissler, Malgaigne, and Wight. Two occurred in males aged 14 and 17; the sex of the third case, aged 53, is not stated. The level of the fracture was different in each—just below the trochanter (Wight), in the upper third of the shaft (Streissler), and in the lower third (Malgaigne), the last being the only instance, besides Fergusson's case (*see Part I*), of shaft-fracture in this third of the femur associated with hip-luxation.

Manipulations which Caused the Shaft-fracture.—In Malgaigne's case of posterior hip-luxation external rotation broke the shaft in its lower third. The same movement caused the upper third fracture in Streissler's case of obturator luxation. Wight's subtrochanteric fracture occurred when the thigh was abducted to reduce a sciatic luxation.

Results.—In Streissler's case alone was the luxation, which was obturator, finally reduced (1908). When the broken shaft had united, he operated, using Kocher's incision, eleven weeks after the luxation had occurred and six weeks after the fracture. The acetabulum was cleared of fibrous tissue and the femoral head was levered into place; he then extended the limb, at first in abduction, then in the straight position. The head slipped from the socket while the wound was healing, and was replaced. Following after-treatment by warm baths and passive movement the patient walked well without support two and a half months after operation; the movements of the hip were moderate. Malgaigne and Wight do not record the end-results of their unreduced cases.

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* In Tunnecliff's case (*see* p. 214) re-fracture of the femoral neck did not interfere with reduction, with which it seems to have synchronized.

These accidents should be treated at once on the lines suggested in *Part I* of this paper (*see* p. 222).

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FRAGILITAS OSSIUM TARDA

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CONGENITAL brittleness of the bones is a condition which has long been recognized. It is evidenced by multiple fractures from insufficient cause; such cases are usually grouped under the general term 'osteogenesis imperfecta'. As the clinical types vary considerably it is usual to make further sub-divisions. Thus Thomson[1] makes two, and in the first puts cases where the disease appears before or at birth and is usually fatal, while in the second he includes cases where the child, born apparently healthy, shows multiple fractures during early childhood or later.

Knaggs[2] in 1924 described four main types: (1) The fœtal—the child is still-born or survives for a short time, with multiple fractures; (2) The infantile—a continuation of (1), the child lives two to three years—a less severe form than the fœtal type; (3) The childhood and adolescent type or fragilitas ossium tarda—to be described here; (4) The adult form characterized by extreme fragility of the bones in adult and later life with multiple fractures.

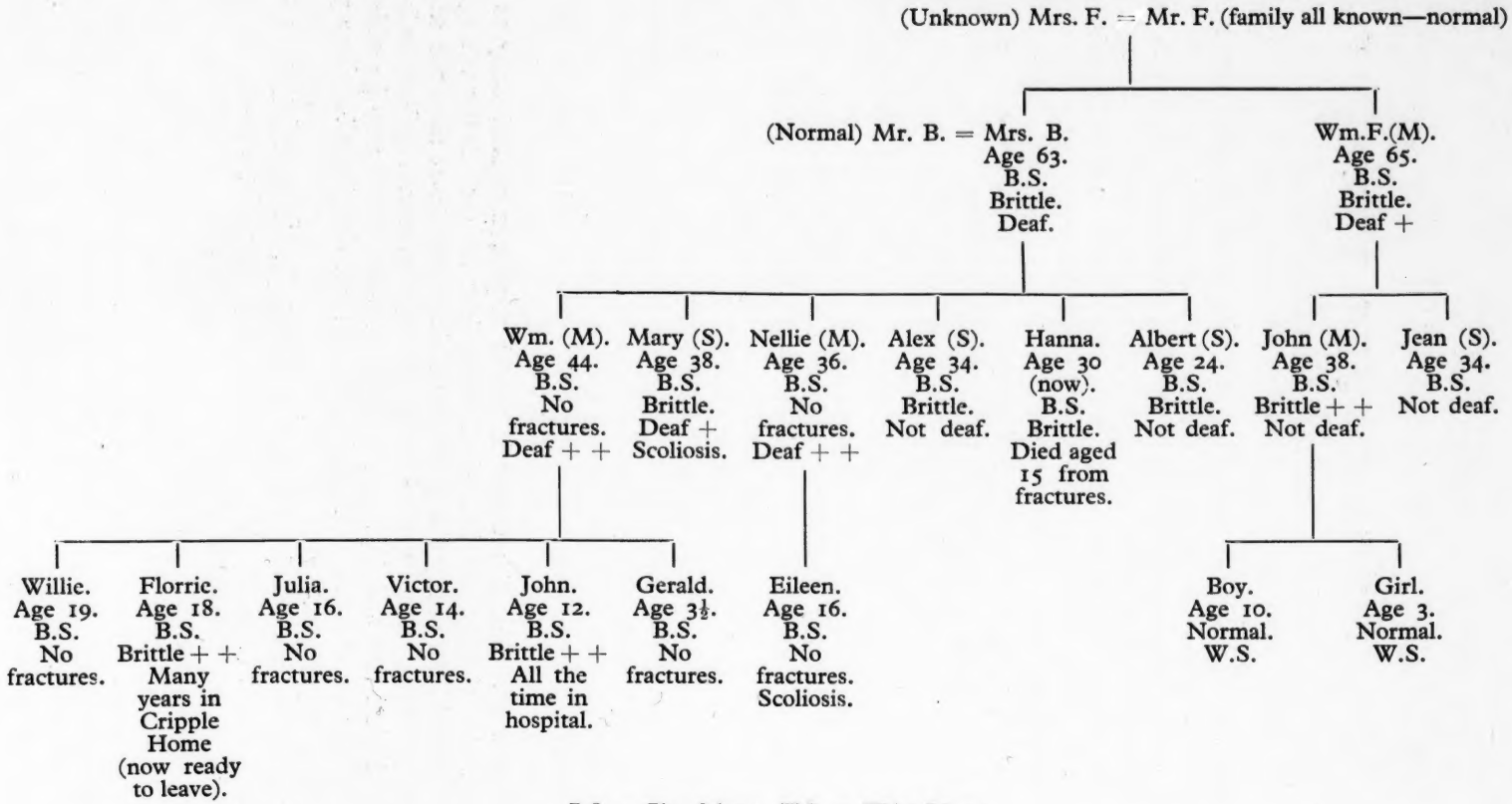
Fairbank[3] similarly divided the condition into four clinical types: (1) The fœtal—similar to Knaggs' No. 1; (2) The honeycombed bone type—older children, extreme fragility, large unossified areas in the bone, no definite family history; (3) The slender bone type—similar to Knaggs' No. 3 or fragilitas ossium tarda; (4) The marble bone type or Albers-Schönberg disease. The last is undoubtedly a variety of osteogenesis imperfecta, but is often considered as a separate entity because so many cases have now been described. Fairbank has excluded Knaggs' doubtful adult form.

Fragilitas ossium tarda is the only other variety which has yielded clinical material with sufficiently constant symptoms and signs to allow a definite syndrome to be drawn up. For the others it would require a central body to collect, segregate, and classify the individual cases, just as the Codman Registry in America was able to clarify the dense fog which surrounded the bone sarcomata.

The following critical study of a family suffering from fragilitas ossium tarda (*see* genealogical tree and *Fig.* 153) is given in order that it may be added to the others already on record and so aid in making more definite at least one group of osteogenesis imperfecta.

Fragilitas ossium tarda is an hereditary disease. It is conveyed alike by mother (*Case* 2) or father (*Case* 3). The brittleness may even miss a generation (*Case* 4), but if it does so, the parent always has blue sclerotics. It attacks with equal frequency and with equal severity both sexes. The outstanding sign or symptom is an extreme brittleness of the bones, which break under minimal strains. The most usual bones involved are the long bones of the extremities, but fingers, ribs, clavicles, etc., may be involved. The fractures rarely appear till after 2 to 3 years of age—hence fragilitas tarda (Looser[4])—and occur only infrequently after 16 to 17; i.e., in the typical case the child has anything from five to twenty breaks during the age

GENEALOGICAL TREE OF FAMILY WITH FRAGILITAS OSSIUM TARDA


(Unknown) Mrs. F. = Mr. F. (family all known—normal)
(Normal) Mr. B. = Mrs. B. Age 63. B.S. Brittle. Deaf.
Wm.F.(M). Age 65. B.S. Brittle. Deaf +
Wm. (M). Age 44. B.S. No fractures. Deaf + +
Mary (S). Age 38. B.S. Brittle. Deaf + Scoliosis.
Nellie (M). Age 36. B.S. No fractures. Deaf + +
Alex (S). Age 34. B.S. Brittle. Not deaf.
Hanna. Age 30 (now). B.S. Brittle. Died aged 15 from fractures.
Albert (S). Age 24. B.S. Brittle. Not deaf.
John (M). Age 38. B.S. Brittle + + Not deaf.
Jean (S). Age 34. B.S. Not deaf.
Willie. Age 19. B.S. No fractures.
Florrie. Age 18. B.S. Brittle + + Many years in Cripple Home (now ready to leave).
Julia. Age 16. B.S. No fractures.
Victor. Age 14. B.S. No fractures.
John. Age 12. B.S. Brittle + + All the time in hospital.
Gerald. Age 3½. B.S. No fractures.
Eileen. Age 16. B.S. No fractures. Scoliosis.
Boy. Age 10. Normal. W.S.
Girl. Age 3. Normal. W.S.

B.S. = Blue Sclera; W.S. = White Sclera;
M. = Married; S. = Single.

period 3 to 17. There is rarely the very large number of fractures found in the fœtal and infantile variety of osteogenesis imperfecta.

Accompanying the brittleness of the bones there is in addition a dull blue discoloration of the sclerotics (*Fig.* 154), most marked towards the iris. This is a more dominant factor than brittleness, so that in a family anything up to 90 or

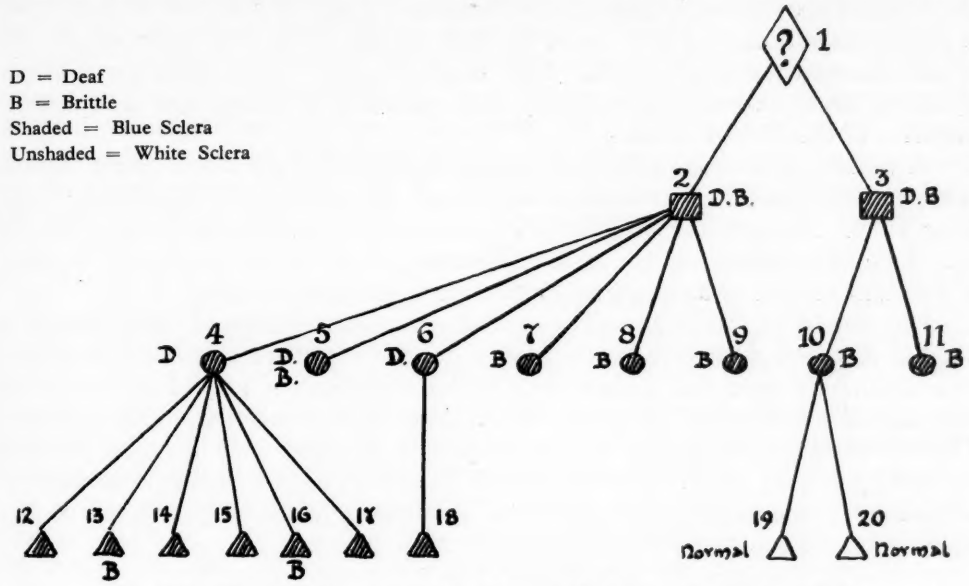


FIG. 153.—Diagrammatic representation of genealogical tree, with cases numbered.

100 per cent may have the blue sclerotics, but roughly only 50 per cent may be expected to show fractures. In such a family no case of brittle bones occurs with a white sclera.

A further item in the syndrome is the deafness. This occurs in approximately 25 per cent of those with blue scleræ. It attacks equally those with brittle bones

FIG. 154.—To show the blue sclera, often described as 'Wedgwood blue'.

(*Cases* 2 and 3) and those who have shown no fractures (*Cases* 4 and 6). The interesting fact is that the deafness only appears after the brittleness subsides. Deafness is rarely present until after twenty years of age. All who recover from fragility of bones strongly emphasize how very hard their bones become, and usually

record with pride the severe accidents from which they have come out unscathed —accidents which, in earlier life, would certainly have broken many bones. This hardening, late in appearing, should possibly be connected with the deafness, which is generally agreed to be of the otosclerotic type.

A tendency to sprain readily is recorded by many writers, and several patients in my series spontaneously gave this information; possibly this is a further proof of a fault in the quality or quantity of the body fibrous tissue, as is evidenced already by the transparency of the sclera. Two members (*Cases* 5 and 18) had a scoliosis of the postural type—also explained by some writers as a further sign of the faulty character of the fibrous tissue.

A well-marked arcus senilis was present in several of the cases. This started to appear with the other sclerosing changes, and was present in a patient as young as 30 years. An early arcus senilis is in some families an hereditary characteristic and of no significance, but the marked frequency with which it is found in cases of fragilitas ossium tarda must be more than a mere coincidence.

The height of this family of four generations was average or rather shorter; but the members with brittle bones were decidedly smaller and some definitely undersized. By some this is claimed to be due to the multiplicity of the fractures, with naturally subsequent shortening due to impaction, absorption, or overlapping. This is obviously a fallacy, as it is an interesting fact that often the same limb is continually broken, whilst the other escapes (Stewart[5]), so that unilateral shortening is what one would expect. This occurred in one case (Woodside[6]), and two inches were removed from the sound leg to straighten the pelvis.

FIG. 155.—*Case* 16. To illustrate the shape of the head and the tilt of the ears. On the right is a boy of the same age for comparison.

A careful examination of the epiphysis shows that early synostosis takes place with cessation of growth. This would appear to start at 15 years and onwards, so that *Case* 13 (fragile) was really further advanced in ossification than *Case* 12, her brother older by two years and non-fragile.

The shape of the skull is a sufficiently constant sign to receive consideration (*Fig.* 155). The appearance from the front is that of an enormous calvarium—almost hydrocephalic—and a very broad forehead with the parietals tending to bulge over the ears; in contrast the lower part of the face and chin are so very small that it

gives the face a triangular appearance (with the apex below). From above, however, the skull is seen to be flat, and thus probably its actual capacity is in no way greater than normal. This is usually explained by the pressure produced by a semi-diffluent brain upon side walls less resistant than usual. This is probably correct, as it is a more marked feature of the fœtal and infantile varieties of osteogenesis imperfecta, where it is admitted that the fragility is greater and where the skull may even be almost of the consistency of a membranous bag.

Biochemical examination of the blood was carried out upon several members in this series by Dr. J. A. McVicker.[7] In these and other cases of fragilitas ossium tarda he found the blood calcium, blood phosphorus, and phosphatase all within the normal limits. This is in accordance with the findings of other workers, and is further confirmed by the fact that no improvement appears to occur in these cases with calcium, phosphorus, parathyroid, or vitamin therapy.

INDIVIDUAL FEATURES

The Scleræ.—The blueness is deep and clear in the child, but gets greyer and duller in old age, although it never disappears as does the tendency to fracture (*see Fig.* 154). This is a well-known familial characteristic. Myles Bickerton[8] states that since 1903 there have been some 463 defective individuals recorded. Of the adults with blue sclerotics 60 per cent had liability to fractured bones, 60 per cent had otosclerosis, and 44 per cent had all three defects. Following the Mendelian Law it is thus a dominant characteristic (Groenow[9]). Its pathology is variously explained. Bickerton says that the sclera is too thin and transparent. Knaggs contends that there is no diminution in the thickness of the sclera and no difference in its microscopic structure, and therefore he holds that the translucency depends upon some exceptional peculiarity of the fibrous tissue of which it is composed. Against this is the fact that Buchanan[10] in an enucleated eyeball found the sclera about one-third of the normal. A further suggestion made by Fridenberg (Alexander[25]) was that the transparency was due to a lack of calcium—a suitable hypothesis and one intended to fit in with the brittleness of the bones and their decalcified appearance. The hereditary tendency of blue sclerotics has been frequently pointed out. Peters[11] in 1908 described a family of eleven members with ten showing blue sclerotics. In 1913 he showed the connection with brittle bones. Deighton,[12] Cockayne,[13] Stephenson,[14] Harman,[15] et al., in interesting pedigrees, have pointed out the dominant hereditary factor that the blue sclera can be. In some of these only was the fragility of the bones mentioned, although it was as early as 1900 that Alfred Eddowes[16] in a very short note to the *British Medical Journal* first pointed out a connection between the two.

Many excellent pedigrees showing the relationship between the two conditions have appeared; those of Olaf Blegvad and Holger Haxthausen,[17], Burrows,[18] Van der Hoeve and de Klyn,[19] Freytag,[20] Bronson,[21] Voorhoeve,[22] Willard,[23] Simmonds,[24] Alexander,[25] Stewart,[5] to mention a few, are typical.

The Bones.—Radiologically in the child in the active period what appears most striking is the extremely slender shaft which stands out in contrast with the expanded extremities. This is most noticeable in the long bones of the limbs. The shaft, although slender, rarely bends; angulation if present is usually due to an old fracture (*Fig.* 156). The cortex is said to be thin, but rather, I think, a cortex

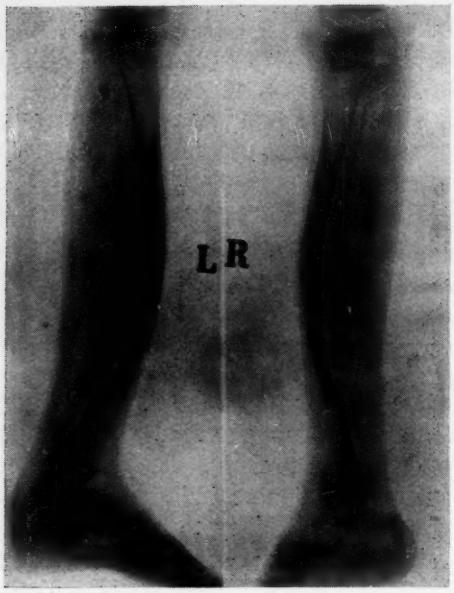


FIG. 156.—To illustrate the decalcified bones, which give a poor contrast with the soft parts.

FIG. 157.—Knee-joint of case of osteogenesis imperfecta of infantile type for comparison.

FIG. 158.—Types of fracture and the structure of the bone. It appears almost cystic in parts.

with little underlying cancellous tissue and enormous medullary cavity is the rule. In the extremities the reverse holds good. There is a wide-webbed honeycomb of cancellous tissue with a thin limiting cortex. The lamellæ in the honeycomb lack the uniformity and regularity of normal bone. As a result of the thin cortex the opposing surfaces are often flattened in weight-bearing, thus giving a joint the appearance of a horizontal slit, e.g., the knee. The appearance of the bone has a direct bearing upon the type of fracture produced. In the *shaft* it is usually, even in the young, a clean transverse fracture. In the *extremities* it is said that a greenstick fracture is common; a better term would be a 'compression' or 'cancellous' fracture. One cortex is broken, but there is considerable impaction as well (*Fig.* 158).

In the cured patient the radiograms are disappointingly normal—the cortex may be denser and thicker than normal; the flat weight-bearing surfaces remain; and there may be the distortion from the old fractures. Beyond this there is little of interest. In the child clean-cut pictures are difficult to obtain, as the bones are less dense than normal and so contrast poorly with the surrounding soft parts; thus the X-rays in this article inadequately demonstrate the condition, although great care was taken in getting a negative with as much contrast as possible.

It is frequently stressed (Stewart[5]) that the fractures appear to favour one limb or one side. This is readily understood by noticing how often the disease, although it is a generalized one, is more marked upon one side than another (*Fig.* 159).

A radiogram of the skull shows the parietal bulge (*Fig.* 160), but in my series there was no other marked abnormality, although Knaggs affirms that the presence of multiple wormian bones is almost a constant feature.

FIG. 159.—*Case* 13. Showing difference in the two legs. The right is much thinner and had ten breaks in all. The left is thicker (cf. fibula). The callus is the result of operation.

Biopsy was performed twice upon one of these patients, and both times the most noticeable feature was the extreme density and hardness of the bone (Irwin[30]). It felt and cut like marble. This is contrary to expectation and certainly contrary to what the radiogram would suggest. However, there must be some connection with marble bones, or the Albers-Schönberg syndrome. In the latter the hereditary tendency is a strong one, and in some cases blue sclerotics have been described.

Professor Young,[29] reporting upon a piece of bone removed in *Case* 13, states:—

*C.*5549.—The general architecture of the bones shows no gross abnormality apart from some increase of density.

The Haversian canals have been encroached upon by a deposition of bone upon their walls. This new-formed bone is rather indistinctly lamellated, contrasting in this respect with the pre-formed bone of the Haversian system, and it would appear to have been deposited in successive stages because it is frequently composed of two or more layers separated by a denser line of cement substance.

These changes can be readily correlated with the increased consistency of the bone, which was such a notable feature clinically. The increased brittleness is less easily explained, but it may be associated with the imperfect lamellation which has been noted in the bone with the Haversian canals.

Deafness.—Deafness as part of the syndrome was first pointed out in 1918 by Van der Hoeve and de Klyn[19], who described two families. In the first, of 22 members, 10 had blue scleræ, 10 had brittle bones, and all were deaf. In the second, of 6 members, 6 had blue scleræ, 5 had brittle bones, and all were deaf. In Olaf Blegvad's pedigree,[17] of the 21 members in three generations, 9 had blue scleræ, 8 had fractures, and 5 had deafness. In addition zonular cataract was a familial disease in this family. It is thus seen that the proportion who show deafness or brittleness in any such family is variable.

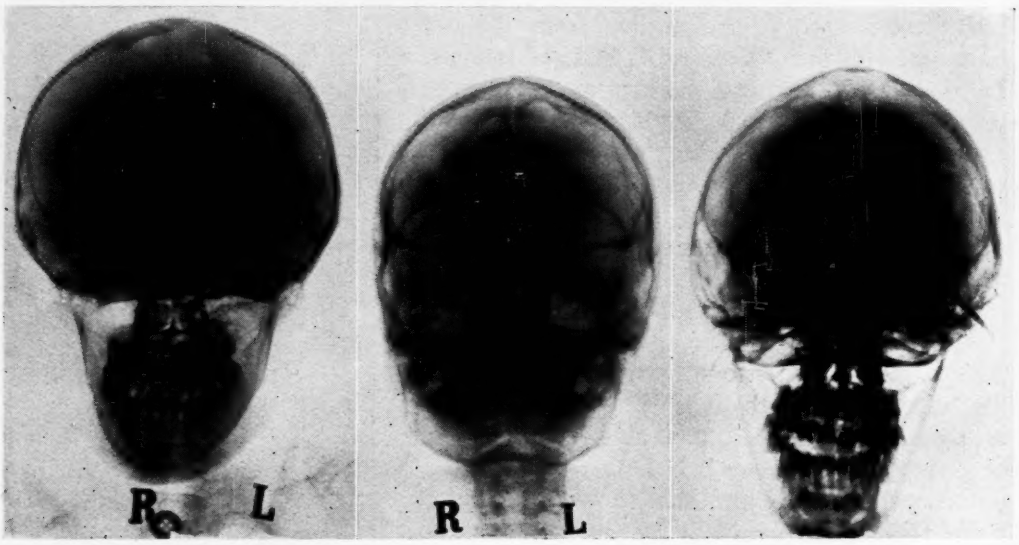


FIG. 160.—Illustrating the shape of the skull. *Case* 13 on the left, *Case* 16 on the right. In the centre is a control case for comparison.

It is natural that the connection between brittle bones and deafness was late in being recognized, as the two do not appear concurrently. When the child is attending the surgeon for repeated fractures deafness has not yet appeared, and later, when as an adult he is being treated for deafness, the brittleness of his earlier days is forgotten or of apparently little connection with his present complaint.

Voorhoeve[22] suggested that the underlying cause of the deafness was labyrinthine disease, but Bronson,[21] Crocco,[26] and others all hold that it is due to otosclerosis. The latter is well recognized by otologists to be a hereditary disease. Stenvers[27] found by radiography that the labyrinthine region was covered with a thick calcareous substance and suggested that deafness was due to a reduction of the nutrition of the part.

Whatever the cause, clinically the deafness comes on insidiously and is not amenable to any treatment. It starts to appear from 20 years and onwards, when the bone fragility has disappeared and when the sclerosis has set in. It is of interest that of the six members of the third generation of my series all had blue sclerotics,

four had fractures, and it is the two who had no fractures who are now deaf. One of those deaf but with no fractures is the father of six children, two of whom were probably the most crippled with fractures in the whole series. The percentage of deafness quoted by any writer is always open to an obvious fallacy in that usually, as in the family here, the last generation has not yet reached the otosclerotic age.

A most striking feature is the return to normality, from being almost crippled, which occurs in these people after a certain age. One man (*Case* 7), a lorry driver, can crank the stiffest engine with an arm that is tortuous and bent as the result of some ten fractures when young. The others similarly are leading strenuous lives. This does not always happen, as in some families the early deformities may have been so great that the patient is left a cripple in adult life.

Cases 2 and 3 are hale and hearty, aged 63 and 65 years respectively; thus the disease does not appear to affect the ultimate expectation of life, although Knaggs[2] states that as a rule such people are not long-lived.

This possibly arises from the fact that one writer mentions high blood-pressure as occurring frequently in these cases—perhaps another proof of the appearance of premature sclerosis? An estimation of the blood-pressure was not carried out in my own series.

SUMMARY

1. A detailed pedigree is given of a family of twenty members of four generations. Of these, 17 had deep blue sclerotics, 10 had multiple fractures, and 5 were deaf. In addition several members had scoliosis, a tendency to sprain readily, and an arcus senilis at a comparatively early age.

2. Such a syndrome is typical of the condition of fragilitas ossium tarda, one of the best known and most constant forms of osteogenesis imperfecta.

3. There is an active period of from 2 to 17 years when fractures occur. Union is normal in time and appearance. This is followed at puberty by a second period of extreme sclerosis. This affects bones, making them exceedingly strong, and the ears, producing deafness of the otosclerotic type and (?) an arcus senilis.

4. After the onset of the second period the patient recovers to enjoy a normal life and reach an average old age.

5. Other features are the broad skull and a normal blood chemistry.

6. The questions still to be settled are: (*a*) Why do the fractures delay in appearing till 2 years of age, approximately? Is it due to the persistence of some of the mothers' hormones? (*b*) Why at puberty does this fragility disappear? Is it due to the appearance of some internal secretion, e.g., ovarian or testicular.

I wish first to record my thanks to all the members of the family here reported. Their interest and help made what might have been a difficult task a pleasure. The willingness with which, even though at inconvenient times, they allowed themselves to be examined and radiographed—from grandmother of 63 to grandchild of 4—is hard to realize. I wish to thank Mr. H. P. Hall for access to *Case* 16, and Mr. Woodside for access to and information regarding *Case* 13; also Professor Young for valuable assistance regarding the pathology of affected bone removed, and Dr. Maitland Beath for help in the interpreting of the radiograms.

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CYSTS IN THE REGION OF THE PANCREAS: WITH NOTES OF A CASE

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Cystic tumours in the region of the pancreas are among the least common of all abdominal cysts. Hale-White,[1] in a series of 6000 autopsies, found only 4 cases, though in a recent publication Mahorner and Mattson[2] were able to report on 88 patients with pancreatic cysts treated surgically at the Mayo Clinic.

Different authors have adopted various methods of classifying these cysts, a comprehensive one being that of Mahorner and Mattson.

I. *Cysts Resulting from Defective Development—*
   1. Cysts in infants.
   2. Cysts associated with polycystic disease of the kidney.
   3. Dermoid cysts.
   4. Inclusion cysts.

II. *Cysts Resulting from Trauma.*

III. *Retention Cysts.*

IV. *Neoplastic Cysts—*
   1. Cystadenoma.
   2. Cystadenocarcinoma.
   3. Teratomatous cysts.

V. *Cysts Resulting from Parasites.*

This classification does not include the possibility of an inflammatory origin for some of the false pancreatic cysts, nor is there any mention of that cystic condition of the pancreas associated with multiple hæmorrhagic tumours of the spinal cord described by Lindau.[3] Any of the retroperitoneal cysts which were classified by Handfield-Jones[4] may also occur in this region.

The cyst most commonly found would appear to be the pseudocyst or hæmorrhagic cyst, devoid of any epithelial lining and believed to result from trauma.

Cystadenomata are extremely rare, being found in only 2 out of 88 cases operated upon at the Mayo Clinic. The pathology of these cysts, in which the cyst is formed by proliferation of epithelium, is a matter for conjecture.

The following case is noteworthy, not only for the rarity of the condition and the size of the cyst, but also on account of its histology, which differs in one important feature from the cysts of this region which have been previously described. A careful study of the histology may throw light on the origin of cysts in the region of the pancreas and help to a clear understanding of their pathology.

CASE REPORT

HISTORY.—The patient, a woman of 52, had noticed for the last few months that her abdomen was increasing in size. She complained of "slight discomfort and a little shortness of breath".

ON EXAMINATION.—The abdominal wall was found to be tightly stretched over a large swelling filling the upper part of the abdomen, being slightly more to the left of the mid-line. The swelling was fluctuant and immovable.

OPERATION.—Laparotomy in June, 1930, showed the stomach stretched like a strap across the left side of the cyst and displaced into the left hypochondrium. On dividing the gastrocolic omentum the pancreas was found lying across the anterior aspect of the cyst. The

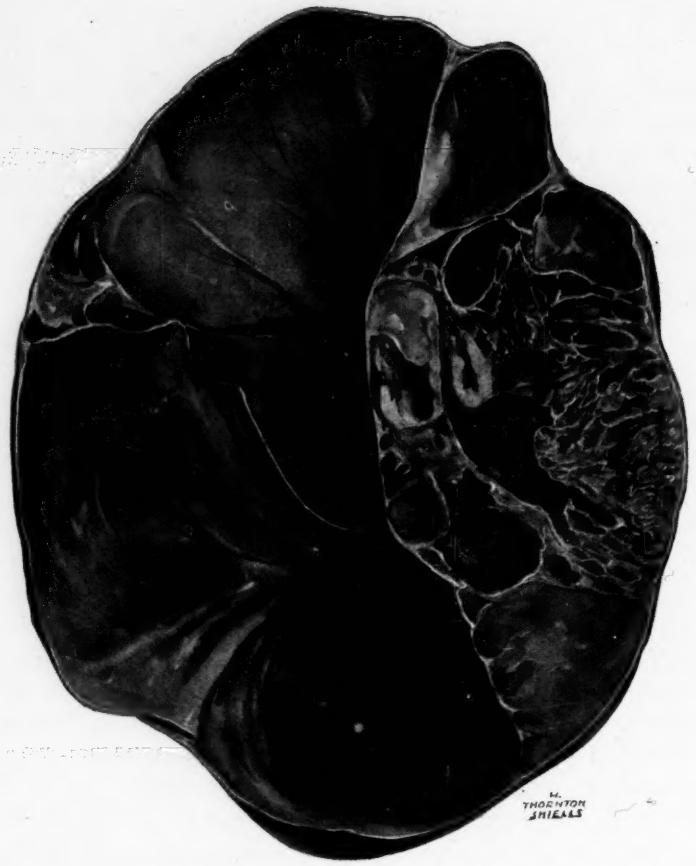

FIG. 161.—Macroscopic appearance of the cyst.

pancreas was easily separated, but a number of adhesions containing venous channels were present between the cyst and the spleen. The cyst was removed together with the spleen. The liver, kidneys, and pelvic organs were examined and found to be normal.

SUBSEQUENT PROGRESS.—Convalescence was uneventful, and the patient remains well four years after operation, except for "a little indigestion and heartburn".

PATHOLOGY.—A thin-walled cyst, a foot in diameter (*Fig.* 161). The cut surface shows numerous loculi containing mucoid material. A section of the wall shows a lining of tall columnar epithelium similar to that of a multilocular ovarian cyst. The septa and cyst wall are formed mainly of fibrous tissue but show traces of somewhat degenerate, but none the less definite, muscle fibres. These fibres are large. Some show peripheral nuclei, but no

striations are visible. In some areas they are placed immediately beneath the epithelium. It is not possible to state definitely the nature of the muscle. (*Fig.* 162.)

Examinations of the fluid contained in the cyst showed no trace of pancreatic enzymes.

DISCUSSION

The description of this cyst closely resembles those described by Stewart[5] and by Carling and Hicks.[6] With regard to the etiology of such cysts there are two views which deserve consideration :—

1. That these Cysts are True Cystadenomata of the Pancreas.—There appears to be no doubt that innocent epithelial tumours of the pancreas do occur, although they are extremely rare. Adenomatous hyperplasia of the islets of

FIG. 162.—Section of septa in cyst showing muscle fibres. (× 185.)

Langerhans has been described, associated with hypoglycæmia. Kaufman[7] has described what appears to be a true cystadenoma of the pancreas, but the cyst was situated in the centre of the pancreas and was of small size. One of the two cases reported by Mahorner and Mattson is considered by these authors to be a true cystadenoma of the pancreas as histological examination of the cyst wall revealed a " cellular structure not unlike the normal pancreas ". As Handfield-Jones states, no cyst in the region of the pancreas should be regarded as of pancreatic origin unless pancreatic tissue is present in its wall or its pedicle.

While true cystadenomata of the pancreas have been found, this explanation of the etiology cannot be applied to the majority of the epithelial cysts found in

this neighbourhood. Their lining epithelium bears no resemblance to that of the pancreas, they occur in contact with the pancreas rather than in it, they closely resemble ovarian cysts, and similar cysts have been found in the retroperitoneal tissues in all parts of the abdomen between the inferior surface of the liver and the region of the broad ligament.

2. The Theory of Developmental Error.—The view that these cysts may result from malposition or sequestration of certain cells in early embryonic life is an interesting one which appears to find general acceptance at the present time.

Having regard to the fact that they possess a definite secretory epithelium there would appear to be several possibilities.

a. That they are Derived from 'Strayed' Genital Cells.—Felix[8] believes that genital cells are not derived from the specially differentiated cœlomic cells but from the segmentation cells at an earlier period of fœtal life. They travel from the region of the cloaca into the root of the mesentery and thence into the urogenital fold. It is possible that some of these cells may fail to reach the urogenital fold and become a source of teratomata.

While this theory is acceptable for rare cases of retroperitoneal and peritoneal dermoids, such as that previously described by one of us,[9] it is difficult to apply it to other cysts unless they can be shown to contain derivatives of all three germinal layers.

It is of interest to note that Ewing,[10] following Nicholson's[11] views, previously discussed by one of us[12] in regard to embryoma of the testis, believes that all testicular tumours, whether epithelial or connective-tissue in nature, are true teratomata, the predominant tissue representing a 'one-sided' development of one of the three germinal layers, the other two being in abeyance. Macleod,[13] in a description of struma ovarii, points out that it is generally accepted at the present time that the thyroid tissue is part of a teratoma and has grown out of proportion to the other structures.

If this 'one-sided' development of a teratoma is accepted in other regions, there appears to be no reason why it may not apply to these epithelial retroperitoneal cysts.

b. That they are of Urogenital Origin.—This theory only differs from the last in that the suggested maldevelopment or 'separation' takes place at a later stage in embryonic life. Zuckerkandl[14] has demonstrated the persistence of mesonephric tubules long after the normal date of their disappearance, and obviously any one of these may be the starting-point of a cyst.

c. That they are of Enterogenous Origin.—Cysts derived from sequestration of part of the gut have been described in a number of cases. Usually unilocular, sometimes multiple, they are lined by columnar epithelium and have traces of plain muscle in the wall. The majority have been found at the ileocæcal angle and in the mesentery. At the junction of the fore- and midgut the pancreas and liver are developed by a process of budding. Abnormal budding can take place, as is shown by the occurrence of congenital duodenal diverticula, and it is therefore possible that some of the epithelial cysts in this region may be derived from the gut.

Of these three views the one suggesting a Wolffian origin is generally accepted. It has the advantage that it serves as an explanation for those cysts similar to the one described in this case but found in the retroperitoneal tissues in the iliac fossæ, and in the broad ligament.

Amongst gynæcologists the view of a Wolffian origin has not found favour when applied to a multilocular pseudomucinous cyst arising in an ovary. Ewing[15] states that cysts of Wolffian origin may arise in the ovary but they are small and situated in the hilum. Wilfred Shaw[16] recorded 23 cases of ovarian dermoids in 9 of which there was a combined pseudomucinous cystadenoma and dermoid cyst—an incidence of 39·1 per cent. Dermoid cyst and cystadenoma formed part of an original tumour with no line of separation. He believes that one area of a dermoid cyst turns into a cystadenoma, a view which is in support of a teratomatous origin.

We have been unable to find any recorded case of a retroperitoneal cyst in this region containing muscle fibres. Their presence in the wall and septa of the cyst in this case is a definite indication of a fœtal or teratomatous origin.

If the muscle is unstriated, its presence and its close association to the lining epithelium is in favour of an enterogenous origin, a sequestration of fœtal gut. If it is degenerated striated muscle, the cyst must be regarded as a teratoma.

The fact that the veins from the cyst joined the splenic vein, part of the portal system, is not decisive evidence in favour of an enterogenous origin, since the spleen is developed around vessels in the dorsal part of the ventral mesentery, and, if we accept Felix's views, there is nothing to prevent a 'strayed' genital cell giving rise to a teratoma in this situation.

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GANGRENE FOLLOWING FRACTURES
(EXCLUDING GAS GANGRENE)

By HAROLD DODD, London

Although innumerable fractures are continually occurring with all degrees of trauma, fortunately gangrene, apart from infection by gas gangrene and other virulent organisms, rarely follows a fracture. I have searched the records, and since the War have found only ten cases published; these are epitomized here. Between the years 1850 and 1914, thirty cases were reported. They are tabulated later and the more interesting are described. Most of the writing is the work of German surgeons.

"The complication of gangrene is an uncommon one if I am to judge from the meagre reference to it to be found in the literature at my command." Thus Ormsby[1] prefaced an article in 1911, when he published two cases.

Investigation of the reports of the London teaching hospitals during the years 1920–30 did not reveal a case, although there must have been a few; they were probably considered unworthy of mention.

Gregora,[2] who has studied the condition, found 4 instances of gangrene in 606 fractures. He stresses that although these cases are rare, they are important on account of: (1) The difficulty of diagnosis; (2) The steps to be taken to prevent gangrene and so save the limb.

This communication describes a patient of Mr. Watson Jones and two of my own. I have extracted the relevant cases from the literature, excluding the numerous ones of gas-producing and other infections. I have omitted the War reports of gunshot wounds complicating bone and vessels; they were exhaustively dealt with by the late Sir George Makins.[3] The present work is confined to the accidents of civil life. From its study I have collected points for the diagnosis of gangrene threatening to complicate a fracture, and to avert its onset various surgical procedures are described.

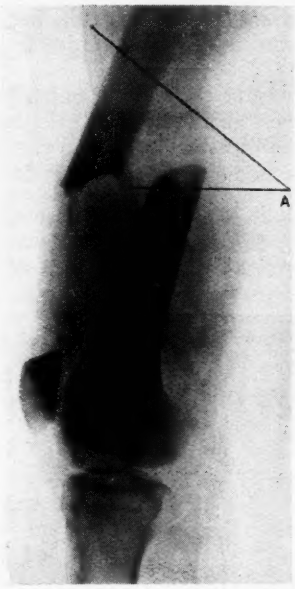
PERSONAL CASES

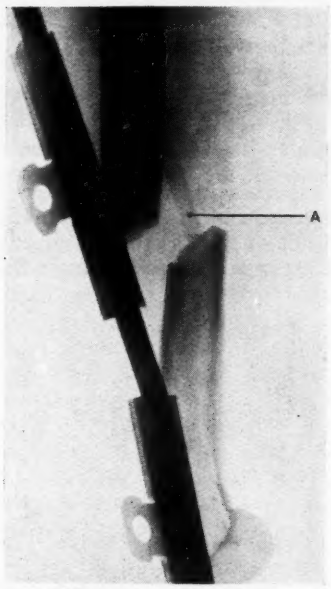
Case 1.—On June 16, 1932, J. B., aged 59, a stableman, was kicked by a horse. His left femur was fractured at the junction of the middle and lower thirds (*Figs.* 163, 164). Over this, on the antero-internal surface of the thigh, was a subcutaneous, freely oozing laceration 1 in. long. The limb was immediately manipulated and mounted in a Thomas knee-splint.

I saw the patient the next day, when the leg was dead white, cold, painless and anæsthetic below the knee. No pulsation was detected in the popliteal, posterior tibial, or dorsalis pedis arteries. A diagnosis of thrombosis and occlusion of the femoral artery at the site of the fracture (approximately at the lower end of Hunter's canal) was made.

The X-ray showed that the fragments were in poor alignment (*Figs.* 163, 164), and thus it was considered that they might be interfering with the lumen of the vessel. A pin was inserted through the os calcis, and a satisfactory position was obtained by extension. After this the level of warmth crept a little farther down towards the middle of the front of the leg.

Observation continued for a month, and then mummified dry gangrene had occurred with a line of demarcation passing round the junction of the lower and middle thirds on the anterior surface of the leg, and at the upper and middle thirds on the posterior surface (*Fig.* 165). Thus the area of distribution of the posterior tibial artery was affected more than that of the anterior tibial.





FIGS. 163, 164.—*Case* 1. Radiograms of fractured lower third of the femur. A indicates the calcified femoral artery.

On July 14—i.e., thirty days after the accident—I amputated the thigh at the level of the fracture and trimmed the end of the bone. Union had progressed to the extent of a mass of gritty callus. On cutting the femoral artery with a scalpel, its wall was felt to be calcareous, but no plaques were visible to the naked eye; the radiograms (*Figs.* 163, 164) show that the femoral and tibial arteries are calcified. The lumen was clear, the intima was smooth and apparently unbroken—there was no change in its colour or sheen. On dissecting the bifurcation of the popliteal artery, it was found to be blocked by two elongated blackish thrombi. They were quite loose in the artery and easily 'popped out'. The lower thrombus was $\frac{5}{8}$ in. long, bent astride the V of the division, and occluding the posterior branch more than the anterior tibial. The upper piece was 1 in. long; it was lying longitudinally in the popliteal artery. The striking feature of these thrombi was that, after being in the vessel for a month, they were still unattached to the wall and quite free in the lumen. The only sign of reaction in the intima was a slight blushing just above the fork, $\frac{1}{8}$ in. in diameter. There was apparently no adherence or attempt at organization in the clots.

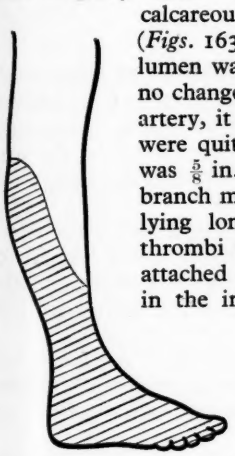


FIG. 165.—*Case* 1. Shows the line of demarcation of dry gangrene, following embolism of the termination of the popliteal artery.

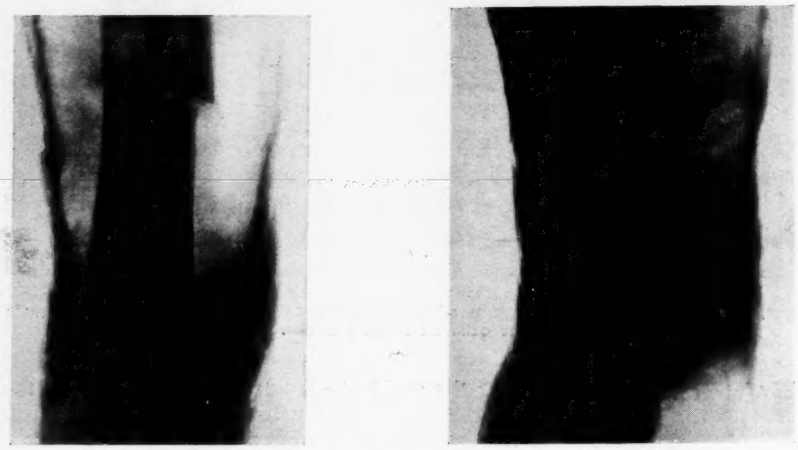
The case suggests that the thrombi arose at the time of the accident from a contusion of the femoral artery at the level of the fracture, although all signs of it had disappeared a month later. Further, it demonstrates that a thrombus may exist in a diseased artery for a long period without becoming organized or fixed, and that, should it move, it would cause a spontaneous, unexplainable embolism long after the incident which had given rise to it had been forgotten.

The patient recovered and is now walking well with an artificial leg. Recently he had a large scrotal hernia which, cured by operation, had been irritated by the bucket of his new limb.

When the gangrene occurred I considered the possibility of a blocked popliteal artery, but I was unable to detect any tenderness over it. However, on dissecting the popliteal artery in the amputated leg, I realized from its deep position that tenderness on palpation would be very unlikely. I was surprised at the length of the wound and the amount of muscle-splitting necessary to expose the region of the bifurcation. In life, the delicate operation of embolectomy in this inaccessible situation would be very difficult, but it would nevertheless be well worth attempting, in view of the grim alternative—inevitable gangrene and amputation.

I have observed sensitiveness over an artery precisely at the site of impaction of an embolus in it, on two previous occasions: on the first it located an embolus at the bifurcation of the common femoral into the superficial femoral and profunda femoris; and on the second it occurred with the brachial artery at the point of origin of its superior profunda branch.

Case 2.—On Nov. 8, 1932, W. H., aged 29, was admitted with a comminuted fracture of the middle of the right tibia and fibula (*Figs.* 166, 167). After reduction under an anæsthetic the leg was encased in plaster from the mid-thigh to the interdigital clefts of the toes.



FIGS. 166, 167.—*Case* 2. Radiograms of fractured tibia and fibula.

The patient was comfortable all night, but next day his toes were swollen and discoloured. This was not relieved by elevating the leg and trimming the plaster, so the latter was removed the same evening. The site of the fracture appeared to be satisfactory; it was not unduly swollen and there was no unusual discoloration. On the next day the colour of the toes had improved; the limb had been mounted on a back-splint with side-pieces during the night. A plaster was again applied.

In twenty-four hours the toes were again swollen, deeply cyanosed, and large blebs appeared on them. The plaster was trimmed but without improvement, and it was finally removed on Nov. 13. The lower half of the limb was dusky and swollen and the large blebs further increased in size. The leg was retained between sand-bags and the foot of the bed was raised on blocks.

By Nov. 15 it was obvious that wet gangrene was present in the foot and lower leg. Gradually the skin fell away, and by Nov. 22 the skin, subcutaneous tissue, and muscles separated from the lower half of the front of the tibia, exposing the bone. A similar process took place behind at the ankle-joint.

On Nov. 29 amputation was performed a hand's width below the tubercle of the tibia. The muscles were greyish-pink and gelatinous; there was only a small amount of bleeding from the peroneal artery and subcutaneous vessels; the anterior and posterior tibial arteries were both thrombosed with a small peri-arterial hæmatoma at the level of the fracture. The flaps were not closed immediately owing to the curious myxomatous appearance of the

muscles. The patient made a slow but uneventful recovery. Large pieces of necrotic muscle from as high as the tuberosity of the tibia separated during the following weeks.

The condition was that of contusion and thrombosis of the anterior and posterior tibial arteries and their venæ comites, due to the injury sustained at the time of the accident.

POST-WAR CASES

In a personal communication Mr. Watson Jones kindly gave me the following details of his case :—

Case 3.—A woman of 32 had been treated for diabetes over several years. On Jan. 5, 1931, she sustained a comminuted spiral fracture involving the lower two-thirds of the tibia and fibula, with a Pott-Dupuytren of the ankle. The fracture was reduced and put in plaster to the upper thigh.

Jan. 8.—Her toes became insensitive, but there was still a fairly good circulation in them.

Jan. 9.—Her toes became cyanosed and the front half of the plaster was removed.

Jan. 10.—There was definite onset of dry gangrene of the toes, but no evidence of pressure sore or plaster pressure was found. Peri-arterial sympathectomy of the femoral artery in Scarpa's triangle was performed under local anæsthesia.

Jan. 11.—There was no improvement in the circulation, and a line of demarcation appeared at the junction of the middle and lower two-thirds of the leg, but it was insensitive as high as the junction of the middle and upper thirds.

Jan. 12.—The leg was insensitive to 2 in. below the knee, and amputation through the lower third of the thigh was performed under gas and oxygen.

The patient made a good recovery and now walks well with an artificial limb. When the treatment was commenced there was glycosuria and a high blood-sugar, but these were controlled with insulin and glucose. The gangrene was dry and the first sign occurred four days after the fracture. There were arteriosclerotic changes in the vessels ; even the femoral artery in Scarpa's triangle was hardened.

Mr. Watson Jones further writes : "No doubt in this case the diabetic factor was as important as the traumatic factor. Apart from this, I know of no case (i.e., of gangrene following a fracture), either personally or in the literature. On the other hand, I suppose that fractures of the neck of the femur occurring so frequently in old people are likely now and again to coincide with a case of senile gangrene of the foot. Although it would seem probable that the combination of two senile conditions should not be uncommon, I have not actually met a case."

OTHER POST-WAR REPORTS

The literature on fractures complicated by gangrene since the War is limited, though in the latter half of the nineteenth century a good deal was written on the subject, chiefly in Germany.

Case 4 (Gregora,[2] 1927).—A 27-year-old tradesman sustained a supramalleolar fracture of the tibia and fibula in a motor and train accident on Oct. 21, 1923. He had a painful hæmatoma in the popliteal space, more towards the outer side. Two days later the left foot was cold to the fork of the malleoli, anæsthetic, and showed a few red-blue spots. Gangrene of the foot set in during the next few days. The patient refused the proposed amputation. Digital evacuation of the hæmatoma in the popliteal space was performed and a pyrexia followed. On Nov. 5 the leg was amputated four finger-breadths above the ankle-joint.

The flesh in the amputated foot was suffused with blood. Neither the posterior tibial nor the peroneal artery was injured at the site of the fracture. The musculature in the remaining part was jelly-like and light grey in colour. The rise in temperature continued and much necrotic substance separated from the stump. On Dec. 11 re-amputation four finger-breadths higher was carried out. At the second operation a few yellow gelatinous particles were still present in the muscle. Recovery followed.

(N.B.—The gangrene here does not appear to be directly related to the fracture itself, but to confusion of the popliteal artery or of the origin of the anterior tibial artery, sustained at the same time as the fracture.)

Case 5 (Gregora,[2] 1927).—A 17-year-old shop-assistant, on July 4, 1925, was thrown out of a swing-boat when it was at the highest point of its swing; she fell head first to the ground. The right thigh was severely swollen by a hæmatoma at the middle and lower thirds, and a supracondylar fracture of the femur was sustained. From the swelling downwards was an almost complete loss of sensation. The pulse in the dorsalis pedis was not discernible. The blood-clot was immediately cleared out and the artery exposed in the adductor canal. It was found obliquely torn through, and the vein also showed a lentil-sized hole. A circular stitch was inserted into the artery after freshening the ends, and a silk stitch into the vein. At the site of the suture in the artery, thrombosis occurred immediately, so that the artery was only clear for a short time. As the bone fragments were difficult to retain, they were fixed with a wire band through another incision.

About the fourth day gangrene of the foot set in from the ankle downwards. Only on July 21 was consent for the amputation given. It was performed four finger-breadths above the ankle, and recovery followed.

Case 6 (Gregora,[2] 1927).—On May 16, 1915, a 56-year-old servant caught her right arm in a washing machine. She received a complicated fracture of the upper and lower arm. Immediately after the injury there was loss of sensation in the fingers, and disappearance of the radial pulse. In the days following, the hand became gangrenous and the lower arm to the elbow-joint was coloured blue. On May 24 amputation was performed in the region of the elbow.

Case 7 (Auvray,[4] 1924).—On Nov. 13, 1923, a 54-year-old woman was admitted with a fracture of the surgical neck of her humerus. The right radial pulse was diminished at first but returned the next day. There was considerable painful œdema and extensive bruising around the fracture. On the fourth day severe pain in the entire arm occurred and brown patches appeared on the back of the fingers. She had a temperature of 38°–39° C. The patches spread to the hand, and the radial pulse was not palpable. Gangrene of all the fingers and the back of the hand started on the sixth day after injury. The diagnosis was thrombosis of the axillary artery secondary to contusion by the fracture.

At operation the brachial artery was exposed at the neck of the humerus. The cellular tissue around it was ecchymosed. Pulsation was present above the fracture, but not on a level with it. The inferior scapular branch was intact; the circumflex arteries were seen, and also the profunda brachialis. The artery was opened at the level of the fracture and a clot evacuated; it had prolongations into the circumflex arteries. The arterial intima was striated and had lost its sheen. An adherent clot was also removed. The artery was then closed with a silk suture.

Steady improvement took place after the thrombectomy, but the gangrenous patches remained stationary and mummified. On Dec. 31 amputation through the wrist was performed.

On March 4, 1924, the arm was normal in semi-flexion. Sensation gradually returned, but the radial pulse was still absent. The blood-pressure was fair, but not quite so good as in the opposite arm. Pathologically, a rupture of the intima led to thrombosis.

(N.B.—Earlier arterial exploration might have yielded a better result; the severe pain suggested impending gangrene.)

Case 8 (Muir,[5] 1924).—A man of 36 fractured his fibula at the upper third, associated with an overlying punctured wound which bled copiously. The position was good. Four days later the foot became cold, bluish, and anæsthetic, and in twelve days there was a line of demarcation immediately above the malleoli, and a dry gangrenous foot. A peri-arterial sympathectomy of the femoral artery, in Hunter's canal, twenty-five days afterwards, had no effect on the gangrene.

A month after the accident amputation at the seat of election was performed, and during it no bleeding was noticed from the anterior or posterior tibial arteries; they were filled with organizing thrombus. The patient recovered.

Examination of the leg showed a localized muscular extravasation of blood around the fracture, which had come from a wound in the posterior tibial artery; this vessel was thrombosed from the popliteal downwards, whilst the anterior tibial, which was also thrombosed, appeared to have been bruised and its inner coat damaged. Sections showed the arteries to be healthy. The circulation to the ankle was apparently carried on by the sural branches of the popliteal artery.

Case 9 (Andler,[6] 1924).—A man of 57 sustained a comminuted fracture-dislocation of the humerus. There was weakness of the arm and impairment of the arterial pulse in the axilla. Operation revealed that the axillary artery was not pulsating in its upper half, and the thrombosed section was resected after ligaturing. Later, the hand and lower third of the forearm became ischæmic, and necrosis appeared. The arm was amputated at the junction of the upper and middle thirds.

Investigation of the amputated limb showed a circular defect in the intima and media, which hung as a flap from its peripheral end, turned in the direction of the blood-stream, and rolled along the lumen (i.e., of the brachial artery).

(N.B.—This suggests, although not definitely stated, that there was an injury to the brachial artery in addition to the resected part of the axillary artery, so that the gangrene would be due to the double lesion.)

Case 10 (Eaves and Campiche,[7] 1921).—A farmer aged 55, was thrown from a car and fractured the surgical neck of his left humerus. He was seen three days later and considerable displacement was present. At no time could pulsation be felt in the radial, ulnar, or brachial arteries. He could still move all his fingers, but the fifth was white and swollen.

On the twelfth day after the injury a patch of ischæmic necrosis appeared on the ulnar side of the forearm near the wrist. After two unsuccessful attempts at reduction, on the thirteenth day the head of the humerus was excised and the shaft inserted in the glenoid cavity. The ischæmic gangrene increased until the patient lost four fingers with part of the metatarsals, the forearm remaining in a typical state of Volkmann's ischæmic paralysis.

The surgeons report that they "could inspect and feel the thrombosed axillary artery exposed during the operation; it was spindle-shaped, hard, and pulseless; the adventitia was still intact, so that a diagnosis of rupture of the tunica intima and media was made. The thrombus was 2 to 2½ in. long, and its removal followed by double ligation of the axillary artery *would have been quite feasible.*"

(N.B.—From the authors' description the thrombus would probably be occluding the origins of the circumflex and superior profunda arteries, thus interfering with the essential anastomotic circulation of the arm and accounting for the gangrene. Early exploration would have been valuable; even though the artery thrombosed again, there was the real possibility that the openings of one or of the other of these branches would have remained patent and permitted an adequate anastomotic flow, or have allowed direct circulation until the smaller collaterals opened up.)

Case 11 (Reichle,[8] 1921).—This is a case of traumatic segmentary vessel spasm. A strong young man sustained a fracture of the middle of the shaft of his femur by having his right leg drawn very sharply backwards and outwards in a railway accident. He was shocked and unable to walk. The upper part of the right leg was swollen and the lower part was cold. There was extensive bruising in the lower third of the thigh. Pulsation in the popliteal and peripheral arteries could not be felt. As it was believed that the right femoral artery was injured, immediate operation was undertaken. The artery was exposed in the popliteal space below, to the middle of the thigh above, but no injury could be established in it, except that it was not pulsating; thus an even higher lesion was suggested. The vessel was therefore exposed in Scarpa's triangle. Once more no abnormality was detected, and careful observation here revealed only very weak pulsation. Owing to the collapsed condition of the patient, the operation was then terminated. The diagnosis lay between traumatic spasm of the femoral artery and a retroperitoneal hæmatoma involving the external iliac artery.

The patient's condition improved after the operation. The right leg became warmer, and the next day its blood-supply was visibly good, and the pulse of the dorsalis pedis was present. Complete recovery followed.

(N.B.—I can find but this one example of traumatic vessel spasm with a fracture, and even this was associated with threatened and not actual gangrene. Nevertheless, I am sure that the wide exposure of the artery and the relief of tension following the trauma was of definite benefit.)

TWENTIETH CENTURY CASES (1900-14)

There are six of these cases; the two published by Ormsby are here described :—

Case 12 (Ormsby,[1] 1911).—Mr. J. P., aged 20, single, fractured his left femur about the middle third. He complained bitterly of the pain in the left leg and foot at the time of the accident. (This is of diagnostic significance with regard to impending gangrene.)

The dorsalis pedis and posterior tibial arteries were not examined. Two days later considerable swelling of the leg and a slight discoloration of the toes were discovered; previously they had been white and cold to the touch. The splints were removed and the limb was placed between sand-bags. The swelling made it difficult to examine the arteries. By the fourth day the discoloration had advanced up the leg, and massage was begun twice daily.

On the sixth day the toes were gangrenous and the leg swollen and mottled, but painless. A diagnosis of occlusion of one or both of the arteries at the site of the fracture was made. The patchy gangrene spread irregularly up the leg, and nine days after the accident the limb was amputated through the thigh at the site of the fracture. At the operation the popliteal artery bled, showing that the femoral artery was intact and not injured at the level of the fracture.

The patient had a secondary hæmorrhage a few days later; the flaps were grossly infected and the thigh became mottled as the leg had been before operation. He died twenty-five days after the accident.

Dissection of the anterior tibial artery from its point of emergence at the interosseous membrane to the ankle showed it to be normal, and fluid injected here appeared from all its smaller branches. Ormsby states, "this demonstration taken in connection with the fact that at the time of amputation the popliteal bled despite the tourniquet, led me to conclude that the cause of the gangrene was not arterial".

(N.B.—Ormsby makes no mention of the actual bifurcation of the popliteal artery where the block may have been, and which, if present, would have occluded the posterior tibial artery more than the anterior (the former being the larger and straighter vessel). The thrombus would probably have been astride the bridge of the V behind the interosseous membrane, and consequently it would not have shown in the dissection of the anterior tibial in the front of the leg. Again, the bleeding popliteal artery, especially noted by Ormsby. was, by means of its anastomotic vessels around the knee, quite compatible with an obstruction at its termination.

He further states that some of the veins seemed to be entirely normal and were flaccid, containing a small quantity of fluid blood, whilst others were filled to bursting with clotted blood; this not throughout their entire extent, but only under the gangrenous spots. He decided that the gangrene was due to venous thrombosis, the result of a phlebitis induced by the external violence done to the part at the time of injury. He concluded that in fractures of the femur help in the prognosis is available by examination of the arteries of the leg and foot.)

Case 13 (Ormsby,[1] 1911).—A man aged 45, an alcoholic subject, infected with syphilis ten years previously, sustained a fracture of his left femur at the middle third, in a train accident. It was manipulated and splinted in flexion with extension. Two weeks later moist gangrene of the leg spread well up towards the knee, but it was not continuous; there were scattered patches of necrotic tissue without apparent definite distribution. It extended deeply into the calf of the leg; the gastrocnemius and soleus sloughed away and exposed the tibia for 3 to 4 in. Amputation above the knee was carried out. The femoral artery and vein appeared to be normal. Unfortunately, the amputated limb was not dissected, and thus the cause of the gangrene was not determined.

The patient recovered. The possibility of a syphilitic disease of the artery must be considered here.

NINETEENTH CENTURY CASES (1850-1900)

There are twenty cases of gangrene following a fracture recorded in this period. I have tabulated their essential details, and I include brief descriptions of the more interesting reports. It should be remembered that many of them would be treated by the pre-Listerian technique, and consequently the results are not strictly comparable with the more recent ones already reviewed.

Case 14 (Chuquet,[9] 1877).—A man aged 65 was run over by a cab in Paris on Feb. 26, 1877. He had a compound comminuted fracture of the left tibia and femur, with openings into the knee-joint at its inner and outer borders. There was not much bleeding.

On the patient's admission to hospital his leg was white and cold; it remained so in spite of efforts to warm it, no pulse being felt in the dorsalis pedis or posterior tibial arteries. Sensation, however, was not altogether lost; the patient could feel pin-pricks distinctly. His general condition was otherwise satisfactory, although he was an habitual drunkard, and a few days previously he had been involved in another accident, when he fractured a rib.

The next day the wound smelt offensively and the tissues gave the sound of emphysema and crepitus on percussion. (This was almost certainly a gas gangrene infection, although it is not mentioned as such in the article.) The foot was now warmer, but not so warm as the right. Neither pulsation nor sensation was detected in the leg. Amputation through the thigh was performed. The bleeding was free and not controlled by compression, since the arteries were so atheromatous.

Two days after the injury there was a foul-smelling discharge from the wound, and a day later the patient died.

Post-mortem examination of the popliteal artery, vein, and their branches showed them to be intact. The artery was atheromatous. In its upper portion was a white fibrous clot, 1 cm. long, firmly adherent to the wall, but it was not completely obstructing the lumen. (This was probably caused by the previous accident, for, as the limb was amputated the day after the fracture, the period was too short for fixation and organization of a thrombus caused by the second mishap.)

There were two more clots at the bifurcation of the popliteal; an upper one about 4 cm. in length and non-adherent, whilst below it and without doubt detached from the former, of the same age and form, was another clot spreading into the anterior and posterior tibial arteries. Careful examination of the arterial wall at this level showed that the intima had been ruptured for 7 to 8 mm., almost encircling the artery.

(N.B.—Whilst the patient probably died from the toxæmia of a gas-forming infection, the gangrene of the limb was due to thrombosis and embolism of the popliteal artery at its bifurcation, the thrombus having arisen at the site of a contusion in an already atheromatous artery. Chuquet comments that a similar case had not been previously recorded, and that it was a rare occurrence—i.e., fifty-seven years ago.)

Case 15 (Jungst,[10] 1882).—H. M., a man aged 20, sustained a compound fracture of the internal condyle of the tibia and head of the fibula on March 17, 1882. The posterior tibial and dorsalis pedis pulses could not be felt. The left foot was cold although sensibility was normal. On the third day it was anæsthetic and subsequently gangrenous.

At the investigation it was found that the media of the popliteal artery was torn for 2·5 cm. at a point 2·5 cm. above the bifurcation; the intima was also torn for 5 mm., whilst the artery itself was narrowed and thrombosed. Diagnosis: contusion and thrombosis of the popliteal artery.

(N.B.—The narrowed artery in this patient corresponds with Stopford's[11] finding in a case of senile gangrene of the foot reported in the BRITISH JOURNAL OF SURGERY. The two illustrate a predisposing factor in the incidence of gangrene of the leg after middle life, i.e., a narrowed and thickened popliteal artery.)

Case 14 (Jungst,[10] 1883).—A man aged 19 sustained a simple fracture of his forearm in a machine accident on Nov. 11, 1883. At first there were only slight symptoms with swelling, but by the fourth day the forearm was ischæmic and the radial and ulnar pulses had disappeared, nor did they return. Gangrene occurred on the sixth day and the arm was amputated.

On examination the brachial artery was apparently intact but thrombosed; its intima was torn for half its circumference 3 cm. above the bifurcation, and the thrombus was adherent to this. The brachialis anticus and joint capsule were also torn at this level. The elbow-joint was full of blood. Diagnosis: contusion and thrombosis of the brachial artery just above the elbow-joint.

(N.B.—The swelling in and around the joint would damage the anastomotic vessels, so that, combined with the cessation of the main blood-supply, gangrene was inevitable.)

Table I.—Analysis of Cases

	Author of Case	Age	Sex	Bone Fractured	Condition of Arteries
1850–1900	Hawkins[14] (1850)	28	M	Humerus: middle third. Open	Not noted
	Holt[14] (1851)	47	M	Humerus: upper. Comminuted	Not noted
	Cadge (1859)	30	M	Femur	Not noted
	Broca[14] (1862)	43	M	Femur. Compound comminuted	Not noted
	Engelman (1862)	20	M	Femur: lower third. Simple	Not noted
	Billroth (1863)	23	M	Femur: lower third	Not noted
	Mash[14] (1872)	38	M	Dislocated and fractured humerus. Supra-coracoid	Not noted
	Defrance[14] (1873)	51	M	Femur. Supracondylar	Atheromato
	Lücke (1873)	Not noted	Not noted	Femur. Double	Not noted
	Hulke[14] (1875)	58	M	Radius with torn muscles. Compound	Veins thr bosed
	Bimbenet[14] (1877)	Not noted	M	Humerus with crushing	Not noted
	Chuquet (1877)	65	M Drunken	Femur: condyles. Tibia: tuberosities. Compound	Atheromato
	Rivington[14] (1878)	19	M	Femur: condyle. Tibia: head	Not noted
	Jüngst (1882)	20	M	Splint: head of fibula; end of tibia. Slightly compound	Not noted
	Jüngst[14] (1883)	19	M	'Forearm.' Simple	Not noted
	Broca[14] (1885)	27	M	Femur: lower part. Tibia: upper part. Complicated by much crushing	Healthy
	Rosenberger[14] (1887)	50	M	Radius	Not noted
	Merkel[14] (1887)	Not noted	M	Radius and ulna. Dislocated wrist. Splintered	Not noted
	Schulz (1897)	32	M Syphilis	Tibia: lower and middle third. Extensive bruising	Syphilitic
	Stromeyer[14] (1899)	Not noted	Not noted	Humerus. Simple	Not noted
1900–1914	Muller (1911)	Not noted	Not noted	Femur: lower and middle thirds	Not noted
	Selenow (1911)	Not noted	Not noted	Femur	Not noted
	Burr (1911)	Not noted	Not noted	Femur	Not noted
	Weinlechner (1911)	Not noted	Not noted	'Fracture'	Not noted
	Ormsby (1911)	45	M	Femur: middle third. Simple	Syphilitic coholic
	Ormsby (1911)	20	M	Femur: middle third. Simple	Not noted
1918–1933	Reichle (1921)	Not noted, young	M	Femur: middle. Simple	Healthy
	Eaves and Campiche (1921)	55	M	Humerus: surgical neck. Much displacement. Simple	Not noted
	Auvray (1924)	54	F	Humerus: surgical neck. Simple	Not noted
	Andler (1924)	57	M	Comminuted with dislocated humerus. Simple	Not noted
	Muir (1924)	36	M	Fibula: upper third. Compound	Not noted
	Gregora (1927)	27	M	Tibia and fibula: lower third. Simple	—
	Gregora (1927)	17	F	Femur: middle and lower third. Simple	—
	Gregora (1927)	56	F	Humerus, radius, and ulna. Simple	—
	Watson Jones	32	F	Spiral of lower tibia and Pott-Dupuytren of ankle. Simple	Diabetic a teritis
	Dodd	59	M	Femur: lower third. Compound	Calcified
	Dodd	29	M	Tibia and fibula: middle. Simple	Normal

GRENE FOLLOWING FRACTURES

SET OF THE GANGRENE ER FRACTURE	DIAGNOSIS OF VESSEL INJURY	OPERATION	RESULT
noted ..	Contusion and thrombosis of brachial artery	Amputation 5th day ..	Not noted
day ..	Contusion and thrombosis of axillary artery	Amputation to shoulder	Not noted
to 5th day	Torn popliteal artery	Amputation 8th day ..	Not noted
day ..	Thrombosed popliteal and femoral veins. Popliteal artery obliterated	Amputation below knee	Died tetanus
noted ..	Aneurysm of lower femoral artery	Ligature of artery ..	Died 7th day
to 4th day	Torn and thrombosed femoral artery ..	Amputation lower third of femur on 16th day	Died pyæmia
day ..	Torn axillary artery at origin of subscapular artery	—	Died 4th day
day ..	Thrombosed popliteal at level of fracture..	No amputation ..	Died 25th day
noted ..	Torn femoral artery	—	Died
day ..	Thrombosed brachial artery, torn in lower third	—	Died 7th day
noted ..	Contused and thrombosed brachial artery ..	Arm amputated ..	Not noted
day (also gangrene)	Thrombus and embolus of bifurcation of popliteal artery	Amputation thigh 8th day	Died gas gangrene
noted ..	Torn popliteal artery and vein	Amputation 2nd day ..	Not noted
day ..	Contusion and thrombosis of popliteal artery (torn, narrowed, and thrombosed above bifurcation)	Amputation lower thigh 8th day	Not noted
day ..	Contusion and thrombosis of brachial artery (torn intima, much peri-articular swelling)	Amputation of arm ..	Not noted
noted ..	Torn, divided, and thrombosed posterior tibial artery	Amputation of thigh after 5 hours	Died 35 hours
noted ..	Torn intima with thrombosis of brachial, radial, and ulna arteries	Amputation above condyles of humerus	Not noted
day ..	Vessels not investigated	Arm amputated ..	Not noted
day ..	Torn and thrombosed popliteal artery and vein	Amputation at femur after 1 day	Recovered
day ..	Contusion and thrombosis of brachial artery	Amputation through arm on 2nd day	Not noted
noted, treatening'	Rupture of middle and inner coats, and thrombosis of the lower part of femoral artery	Amputation thigh ..	Died
noted ..	Laceration of femoral vein	Amputation thigh ..	Died 'officious treatment'
noted ..	Contusion and thrombosis of femoral artery	Amputation thigh ..	Not noted
day ..	Rupture of artery and vein	Amputation	Died
2nd week	? Diffuse arterial hæmatoma of popliteal artery	Amputation through thigh	Recovered
to 6th day	Thrombosis + ? embolism (2) of the bifurcation of the popliteal artery	Amputation through thigh	Died
tened ..	Traumatic segmentary spasm of femoral artery	No amputation ..	Recovered
to 12th day	Thrombosed third part of axillary artery for 2 to 2½ in.	Lost 4 fingers, part of metacarpals. Ischæmic contracture of forearm	Recovered
to 7th day	Contusion and thrombosis of axillary artery	Embolectomy on axillary artery. Amputation through wrist	Recovered
noted ..	Contusion and thrombosis of brachial artery	Amputation	Recovered
to 6th day	Contusion and thrombosis of posterior and anterior tibial arteries	Amputation at 'seat of election'	Recovered
to 5th day	? Thrombosed popliteal artery	Amputation middle of leg and higher later	Recovered
to 4th day	Contusion and thrombosis of femoral artery	Amputation through lower quarter of leg	Recovered
to 4th day	—	Amputation through elbow	Not noted
day ..	Probably thrombosis of anterior and posterior tibial arteries	Peri-arterial sympathectomy Scarpa's triangle 6th day. Amputation thigh 8th day	Recovered
day ..	Embolus at bifurcation of popliteal artery	Amputation through lower thigh	Recovered
day ..	Contusion and thrombosis of anterior and posterior tibial arteries	Amputation of leg at seat of election	Recovered

THE CASES ANALYSED

Table I is a general analysis of the cases of gangrene following fractures.

Age and Sex Incidence (*Table II*).—Of 31 patients, 27 were men and 4 were women; thus men easily predominate. The largest group (11) occurs in males between the ages of 15 and 30 years; this is the most active age-period. At the other end of the scale there are nine patients over 50, of whom two are women.

Table II.—Analysis of the Age and Sex Groups

Age Groups	15–30 Years	31–45 Years	46–60 Years	61–75 Years	Not Noted	Total
Men ..	11	5	7	1	3	27
Women ..	1	1	2	–	–	4
Total	12	6	9	1	3	31

The Bones Affected.—The lower limb was affected 23 times, distributed as follows:—

The femur 16 (lower third)
The tibia 2
The fibula 1 (upper end)
The tibia and fibula 2
The femur and tibia 2

The upper limb was involved 12 times, divided thus:—

Humerus 7 (upper half)
Radius and ulna 4
Radius, ulna, and humerus 1

Table III.—Analysis of the Lesions and their Location

Diagnosis	Total	Femoral Artery	Popliteal Artery	Anterior and Posterior Tibial Arteries	Third Part of the Axillary Artery	Brachial Artery	Remarks
Embolism of main artery	3	–	3	–	–	–	—
Contusion and thrombosis of main artery ..	20	4	3	3	4	6	—
Complete tearing and thrombosis of main artery	10	3	4	1	1	1	—
Diffuse traumatic aneurysm	1	1	–	–	–	–	—
Traumatic segmentary vessel spasm	1	1	–	–	–	–	—
Injuries, nature doubtful	2	–	–	–	–	–	(1) Lacerated femoral vein (2) '? popliteal artery'
Total		9	10	4	5	7	

Thus gangrene is most likely to follow fractures of the proximal half of the humerus in the arm, and those of the distal third of the femur in the lower limb.

Predisposing Factors.—In 5 cases these were mentioned. They are calcification of the artery in 2, syphilis in 2, and diabetes in 1. As 9 of the patients were over 50, there would probably be some degree of arterial disease present in them.

The Exciting Causes of the Gangrene.—*Table III* shows the exciting causes of the gangrene and indicates that the femoral, popliteal, and brachial arteries are most liable to injury in association with fractures.

The Type of Gangrene.—This was dry in 6 cases, wet in 3, and 'threatening' in 1. In the remainder of the series its nature was not stated.

The Time of Onset of the Gangrene after the Injury.—Throughout the series it occurred during the third to the sixth day after the actual injury, usually on the fourth.

The Results.—Amputation was performed on all but four occasions. The site of this was through:—

The thigh in 14	The wrist in 1
The leg in 5	The hand in 1
The arm in 8	The place was not specified in 2

Table IV shows an analysis of the results.

Table IV.—Analysis of the Results

	1918–32	1900–14	19th Century	Total
Total cases	10	7	20	37
Cases recovered ..	9	1	1	11
Cases died	–	4	9	13
Results unknown ..	1	2	10	13

Thus, stated baldly, out of 24 cases, 11 recovered and 13 died, so that there is apparently a heavy mortality of 54 per cent.

However, further investigation reveals the interesting significant facts that since the War, of 9 cases fully reported, all have recovered. Between 1900 and 1918, 4 out of 5 cases died—an 80 per cent death-rate, except that in two patients the result is not stated, but nevertheless 4 deaths in 7 cases is very high. Before 1900, 9 out of 10 cases succumbed; of these last fatalities, probably most were due to infection of the wound received at the time of the injury or at the amputation. Tetanus is mentioned once or twice, but antitetanic serum was not then known. Lister's technique was only in its infancy during some of this period and was not in general use. Since the opening of the antiseptic or aseptic era the mortality has strikingly fallen to the negligible figure of the present day—an eloquent testimony to the life-saving value of Lord Lister's work.

DISCUSSION

1. The Interruption of the Blood-supply.—Gangrene may follow after several types of injury to the main artery of the limb. These are:—

a. Complete division of the chief vessel by sharp or blunt trauma.

b. Penetration of the principal artery, e.g., by a fragment of bone.

Groups *a* and *b* usually result in cessation of the blood-supply by thrombosis or by the formation of a diffuse traumatic aneurysm.

c. Contusion or rupture of the intima, or of the media and the intima together, leading to vascular obstruction by thrombosis.

d. Embolism by a thrombus which has originated in the artery at the level of the injury becoming detached and lodging more distally as an embolus; it is usually located at a bifurcation, e.g., at that of the popliteal artery.

Prognostically, Group *a* is more favourable than Group *c* (Gregora[2]), as in the latter there is more likely to be coincident injury to the tissues, including the anastomotic vessels.

e. A condition of segmentary vessel spasm may also result in threatened or actual gangrene; it was apparently first described by Finalij.[12] The spasm lasts up to twenty-four hours. In one of Finalij's patients peripheral gangrene occurred. I have only been able to find a single true example of this affection associated with a fracture (*Case* 11); gangrene did not actually happen, but definitely threatened. The prompt operation probably played a part in averting it (Reichle[8]).

In addition to the above accidents to the main vascular supply, all degrees of trauma to the tissues, to the nerves, to the lymphatics, and to the smaller vessels are associated. In a good subject the lesser arteries if intact will easily carry on the collateral circulation, but if, in addition to the main vessel lesion they too are involved, then gangrene is almost inevitable.

Factors of the general health also predispose to and influence the amount of and the incidence of the gangrene which occurs, e.g., diabetes, syphilis, or alcoholism, and, more particularly, the local state of the arteries, such as narrowing or calcification (*see Figs.* 163, 164).

2. Why Certain Vessels are Injured.—An explanation for the apparent frequency of damage to certain blood-vessels by fractures is worthy of note. Briefly, the underlying principle is that the more mobile the vessel, the less likely it is to be involved by accidents. On the other hand, the more fixed an artery is by fascia, by aponeurosis, by proximity to bone, or by several branches arising close together, the more likely it is to be hurt, for it is unable to slip away from the violence (*Figs.* 168, 169).

THE CHARACTERISTICS OF THE INJURED VESSELS.—

a. The Lower Third of the Femoral Artery.—This is restrained as it passes close to the femur under the tough fibrous arch in the adductor magnus. Above this, the artery is embedded in Hunter's canal and is more removed from the bone.

b. The Bifurcation of the Popliteal Artery.—This is anchored by the fibrous arch of the soleus, by the passage of the anterior tibial artery over the interosseous membrane, by its proximity to the fibula, and by the origins of small anastomotic branches to the knee-joint (*Fig.* 168).

For the cross-section through the termination of the popliteal artery (*Fig.* 168) I am indebted to Professor Harris, of University College Hospital. He very kindly sectioned a leg which was photographed; such a diagram is, I think, unobtainable from the text-books. He pointed out the comparatively intimate association of the bifurcation with the neck of the fibula. He showed me radiograms demonstrating

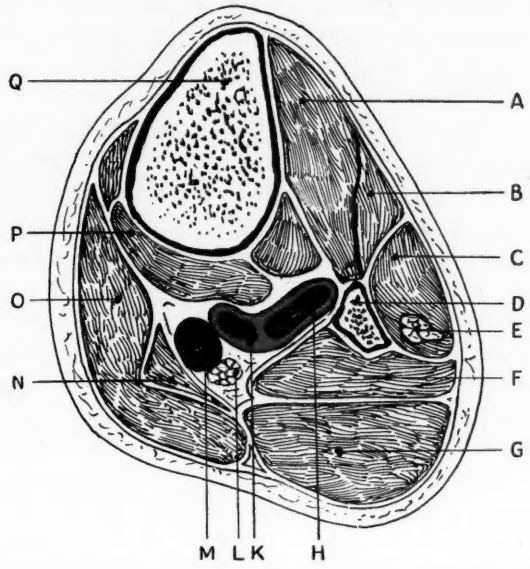


FIG. 168.—Photographic section through the upper third of the right leg at the level of the bifurcation of the popliteal artery; this is at the origin of the anterior tibial artery, as it arises from the termination of the popliteal artery and runs horizontally forward to the anterior compartment of the leg in close proximity to the fibula. A, Tibialis anticus; B, Extensor digitorum longus; C, Peroneus longus; D, Fibula; F, External popliteal nerve; F, Soleus (fibular head); G, Gastrocnemius; H, Anterior tibial artery; K, Termination of the popliteal artery and beginning of the posterior tibial artery; L, Internal popliteal nerve; M, Internal popliteal vein; N, Soleus (tibial head); O, Gastrocnemius; P, Flexor longus digitorum with tibialis posticus antero-laterally; Q, Tibia.

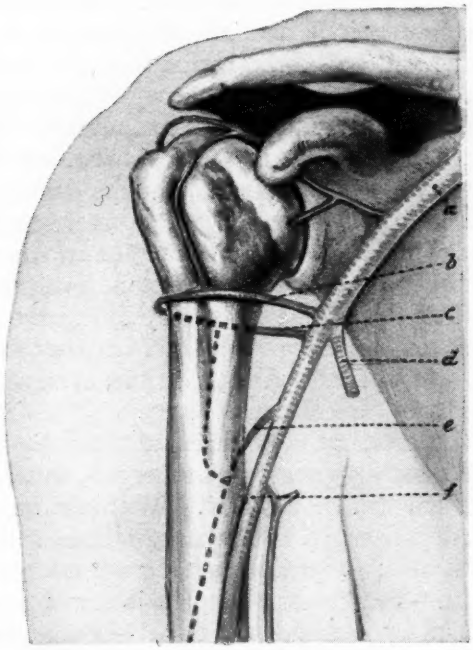


FIG. 169.—Semidiagrammatic drawing of the third part of the axillary artery and the beginning of the brachial artery, illustrating the origins of the subscapular artery (*d*), the anterior and posterior circumflex arteries (*b* and *c*), and the profunda brachialis (*e*). It shows the consequent fixation of the axillary artery, and quick diminution in the calibre of the beginning of the brachial artery. *a*, Axillary artery; *b*, Anterior circumflex artery; *c*, Posterior circumflex artery; *d*, Subscapular artery; *e*, Profunda brachialis artery; *f*, Brachial artery.

on the inside of the neck of the fibula a slight groove which is made by the anterior tibial artery as it passes from behind to the front compartment of the leg. This emphasizes the vulnerability of the artery to injury in fractures of this region of the fibula.

c. The Anterior and Posterior Tibial Arteries.—These are also close to the fibula, more especially in the upper half of the leg, and further they lie on or are covered by aponeurosis. Professor Harris pointed out that the anterior and posterior tibial arteries are closer to the fibula than to the tibia. He suggested that "anterior and posterior fibular arteries" would be a more correct name for them. Muir's case (*Case* 8) of a fracture of the upper third of the fibula followed by gangrene illustrates this point.

d. The Third Part of the Axillary Artery and the Brachial Artery (*Proximal Portion*).—The axillary artery is comparatively fixed and somewhat tied by the origins of its branches, the subscapular, the anterior and the posterior circumflex arteries, arising close together (*see Fig.* 169) (Gregora[2]). Below this the brachial artery is mobile, so that, as is to be expected, the injury occurs at the junction of the mobile and relatively immobile parts.

THE DIAGNOSIS OF INJURY TO AND OCCLUSION OF A MAIN ARTERY

All or various combinations of the following signs and symptoms may be found :—

1. *Arterial Pulsation.*—The presence of pulsation above the injury, with impairment of or loss of it below this level. This characteristic may be of immediate or gradual onset; it is a dependable and important one. Of course comparison with the normal (i.e., with that of the uninjured limb), is necessary, for the poor general condition of the patient may explain the weak pulse.

2. *Sensation.*—Below the traumatized place an alteration from the normal sensation is present. It may be anæsthesia or paræsthesia, or, on the contrary, severe persistent pain localized about the seat of the damage, or even distributed throughout the entire limb. When the latter occurs, especially after reduction and splinting, I consider gangrene is very likely. (Auvray's and Ormsby's cases.)

3. *Appearance.*—Blanching, cyanosis, and 'stone' coldness of the limb below the hurt area. Later bullæ and large blebs may form on the skin.

4. *Paralysis.*—Loss of muscle power, e.g., inability to make the slightest movement of the foot or toes after a fractured tibia, even with considerable effort. Muscle sense also seems to be impaired.

5. *Hæmatoma.*—The presence of a hæmatoma and bruising about the vessel. This may not be immediately apparent on inspection, but if the part is palpated by the fingers, the tension will be detected. When the hæmatoma is under the deep fascia, then staining from it will not show until a few critical days have passed, and during this time gangrene may become established.

6. *Local Tenderness.*—Tenderness and pain localized precisely over the chief vessel at the point of injury is sometimes found—it suggests thrombosis. However, in a deeply situated artery like the popliteal, in a stout patient, or when there is considerable traumatic swelling, this feature will not be found. If similar localized tenderness and thickening is observed over the artery where it narrows or bifurcates distal to the injury, an embolus there is suggested.

7. *Blood-pressure.*—A gradual fall in the blood-pressure of the limb as compared with the systemic figure denotes a failing local circulation (Auvray[4]).

8. *Radiograms.*—A careful inspection of the radiograms may reveal signs of calcified arteries. In this event little vascular compensation is to be expected after arterial injury, and extensive gangrene is probable. This peculiarity indicates a high level for the amputation in order to ensure well-vascularized flaps and consequent sound healing. (*See Fig.* 163.)

THE TREATMENT OF THREATENED GANGRENE

When the onset of gangrene following a fracture is suspected, in view of the inevitable amputation when it occurs, surgical interference even though it may be heroic is justified. "Look and see" rather than "wait and see" is then quite rightly the surgeon's governing principle. That all fractures should be reduced and suitably splinted as soon as possible after their occurrence is a *sine qua non.* The standing order in force in some hospitals, that this treatment must be carried out within four hours of the patient's admission, is worthy of general adoption.

The systemic indications of diseased arteries, and especially the previously described signs of interference with the circulation in a limb, will be watched for in all bone injuries. Assistants will be instructed to look for and to report them. The urine is examined for sugar.

When the suspicion of impending gangrene has arisen, a definite intimation of progress to recovery or to gangrene is sometimes obtainable by recording on the skin in coloured inks, say at four-hourly intervals, the levels of: (1) Altered sensation (or anæsthesia); (2) Modified temperature; (3) Variation in colour. Temperature is indicated by black ink, sensation in red, and colour by a blue skin-pencil. Each line is appropriately labelled with the time of the observation. (Mr. Watson Jones's case illustrates the value of this.)

When the symptoms have appeared and have not shortly subsided, wide exploration of the main vessels at the site of injury is promptly suggested. The objection that by such a procedure a simple fracture is converted into a compound one, with its attendant risks of sepsis, is with modern surgical technique fortunately a small and negligible one when compared with the possible loss of a limb by gangrene. In a compound fracture free 'opening up' of the traumatized area by promoting drainage probably lessens rather than increases the sepsis. According to Böhler[13] it is the best preventive of tetanus and gas gangrene.

During the investigation of the vessels, whether they are found normal or damaged, hæmatomata will be evacuated, and the additional valuable effect of reducing tension in the traumatized tissues will be achieved. The latter will relieve lymphatic and venous stasis and permit the resumption of these circulations, whilst the formation of the collateral anastomosis by the smaller arteries will be assisted. The pressure of exudate and of extravasated blood may be sufficient to prevent totally or partially the development of these lesser compensatory circulations.

When the vessels have been defined the further procedure will depend on the findings, on the patient's condition, on the surgeon, and on his equipment. One of several operations may be necessary:—

1. Torn or divided arteries will call for repair, either by ligature of the ends, or, if possible, by excision of the injured section followed by end-to-end

anastomosis. The latter is only possible when a short length of the vessel is injured. It aims to achieve the ideal, and occasionally it will be successful.

2. The artery may be found apparently uninjured but thrombosed—one or two cases in this series were so affected. The vessel is temporarily occluded above and below the block (a tape ligature does this satisfactorily), and it is then opened longitudinally and the thrombus is removed. The upper ligature is now released in order to establish that all the clot has been removed and that the circulation is present from above. Occasionally more clot is washed out by the blood-stream by this manœuvre. The artery is controlled again and the lower tape is similarly dealt with. If blood flows from below (this will be a rare occurrence after an accident), it will show that the collateral circulation is working, and the continuity of the arterial lumen will be established. The wound in the vessel is sutured with the finest vaselined silk, threaded in a slender eyeless needle, as used for ophthalmic surgery.

When the artery is opened, the intima or media may be seen to be damaged, e.g., a large tear, or even a flap of it may be detached; if the occasion is suitable, the injured section is excised and an end-to-end anastomosis performed.

No attempt is made to close the wound; it is made of sufficient extent to gape open, and is dressed with gauze and sterile vaseline, magnesium sulphate, and glycerin paste, or 1–1000 acriflavine and paraffin emulsion (Boots). Silkworm gut sutures may be inserted and knotted at their extremities, when, should the limb live and the progress of the wound be satisfactory, they are tied four to seven days later. If immediate closure of the wound is considered advisable, then around it several incisions extending through the deep fascia should be made for drainage and to relieve and prevent tissue tension by extravasations and traumatic œdema.

3. If the artery is normal at the level of the injury, the possibility arises of a thrombus having formed and passed distally as an embolus. When this rare event is present, embolectomy at the affected point is indicated. *Case* 1 illustrates an opportunity for it.

Careful inspection over the surface markings of the artery will occasionally reveal signs indicating an impacted embolus. The common sites for them to lodge are at the termination of the axillary, and at the bifurcations of the brachial and of the popliteal arteries. The exposure of the termination of the popliteal artery is a large dissection, but it is certainly worth while, and the necessary extensive muscle-splitting should be confidently undertaken (*see Fig.* 168). Palpation by the tip of the finger of such a vessel will reveal the obstruction as a firm thickening, with pulsation above the point and a silent contracted artery below it.

4. When a diffuse traumatic aneurysm has formed, a tourniquet is applied above the swelling. If the lesion is near to the trunk this is not always practicable, so the main artery is exposed and temporarily controlled by a tape ligature through normal tissue closely above the lesion. The aneurysm is incised approximately in the line of the surface marking of the main vessel and the blood-clot evacuated. The space is irrigated with hot or iced saline, and an attempt is made to define and suture the artery as the circumstances indicate.

Further, the work of the late Sir George Makins[3] showing the undoubted benefit of ligature of the main veins of a limb when the chief artery is injured,

should, I think, be followed in each case, but frequently the vein is already thrombosed, so that the need does not always arise.

Peri-arterial Sympathectomy.—If the patient's condition permits, some form of peri-arterial sympathectomy is performed on the healthy artery above the level of the injury at the same time as the previous explorations. It will probably have a favourable effect by the resulting temporary vasodilatation existing long enough to nourish the limb through a few critical hours.

Finally—and this point is worthy of stress and of repetition—surgery, to be effective, should not be delayed; it must be thorough and extensive, and undertaken in a spirit of optimism. Four to six hours would be the longest period to watch a suspect limb before interference, for a careful exploration is very unlikely to have any other than a good effect.

SUMMARY

1. The recorded cases of non-infective gangrene following various fractures are described and tabulated.

2. The causes and symptoms of threatened gangrene are discussed.

3. A method of treatment in the event of the onset of gangrene being suspected is detailed.

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CHRONIC EPIDIDYMO-ORCHITIS OR FIBROSIS OF THE TESTICLE OF FILARIAL ORIGIN*

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During the last two years I have had the opportunity of examining and treating several cases of chronic epididymo-orchitis of non-venereal origin. I was convinced, after careful urological and bacteriological examinations, that the recurrent attacks of testicular inflammation in these patients were not due to the gonococcus or the *Bacillus coli*. I was then induced to investigate the nature of filarial infection of the genital tracts in the male. It is well known that very often the so-called idiopathic vaginal hydrocele in India, and occasionally sterility, are due to complications of filariasis. During operations on the scrotal tumour marked enlargement of the testicles is frequently met with, and the condition may persist for years after the operation. Little was known about the ultimate fate of such a testicle. Pain of a dull aching character is usually complained of, and on examination the testicle is found to be firm in consistency and heavy. In several cases one testicle was found to be as large as a duck's egg, and occasionally the condition is bilateral. It is obvious that the investigation and elucidation of the pathological relationship of the filaria in chronic enlargement of the testicle are beset with many difficulties. The following case is therefore of great interest.

A. J., aged 25, was admitted under my care on April 2, 1933, and discharged on April 30.

History.—The patient complained of persistent pain of one week's duration in the right testicle, which had been getting enlarged for the last five years, but it was not causing much inconvenience to him. There had been no fever. In November, 1932, he had an attack of pain in the testicle with much swelling, which persisted after subsidence of pain in the course of a fortnight. He had another similar attack in February, 1933, resulting in further increase in the size of the testicle.

The patient had suffered both from syphilis and gonorrhœa nearly three years previously. There was no history of aspiration of the affected side for a hydrocele.

On Examination.—The skin of the scrotum was slightly thickened and there was some scabies, but it was not elephantoid. There was a small hydrocele on the left side. Otherwise nothing abnormal could be detected in the testicle or the cord. On the right side the testicle was much enlarged. It was pyriform in shape, regular in outline, and slightly tender on pressure. On measurement its maximum longitudinal and transverse diameters were found to be nearly 6 in. and $3\frac{1}{2}$ in.

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* Being a paper read at a clinical meeting of the Calcutta Branch of the British Medical Association on Aug. 11, 1933.

respectively. It was uniformly firm in consistency except anteriorly at the junction of the lower and middle thirds of the tumour, where it was soft and almost fluctuant and the skin of the scrotum was adherent to the tumour for an area 1 in. across. It imparted a sense of weight to the examining hand. Testicular sensation was present. The epididymis could not be palpated separately and there was no vaginal hydrocele. The spermatic cord was nearly twice the normal size in thickness and was lymphangiectatic, but the vas deferens appeared to be unchanged. There was no urethral discharge, and on rectal examination nothing abnormal was noticed. The abdominal lymphatic glands—viz., pre-aortic and iliac—were not palpable. Inguinal glands were palpable on both sides.

The general health appeared to be good, but pyorrhœa alveolaris was present.

On ADMISSION.—Temperature 99°, pulse-rate 112.

Urine :—

Specific gravity	1010
Sugar	Nil
Albumin ..	Nil

Blood-pressure :—

Systolic ..	110 mm. Hg.
Diastolic ..	75 „ „

Examination of Blood :—

Leucocytes ..	10,800
Polymorphonuclears	78 per cent
Lymphocytes ..	18 „ „
Large mononuclears	2 „ „
Eosinophils ..	2 „ „
Malarial parasite	Nil
Microfilaria ..	Nil

Wassermann reaction: Moderately positive. Prostatic smear: Negative.

TREATMENT.—

General.—Mist. pot. iodide was given for a fortnight, and the daily dose of the iodide was gradually increased to 45 gr. With regard to scabies, the routine treatment with sulphur ointment was carried out for three days. The patient was referred to the dental department for the treatment of pyorrhœa alveolaris. Glucose was given freely by the mouth before the operation.

Local.—The semi-fluctuant area was incised under local anæsthesia and about a drachm of thick turbid fluid was evacuated. It was sterile on culture. The tumour, with all the adherent skin, was removed under local anæsthesia with novocain. The spermatic cord was divided just below the inguinal canal. Lymphangiectasis of the cord was well marked.

Result.—The patient had an uneventful recovery and the wound healed by primary intention. On his discharge from the hospital, he was advised to continue the antisyphilitic treatment and to report himself once every month for further examination and for the aspiration of the hydrocele on the other side.

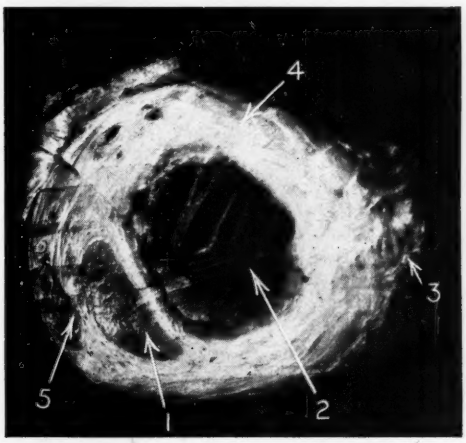

FIG. 170.—Showing: 1, Testis; 2, Epididymis; 3, Spermatic cord; 4, General fibrosis and obliterated vaginal sac; 5, Site of adult filariæ.

PATHOLOGICAL EXAMINATION.—

1. *Macroscopic Appearances.*—The large tumour was pyriform in shape and smooth in outline. Anteriorly the skin of the scrotum was adherent at the junction of the middle and lower thirds of the tumour, where there was a necrotic ulcerating

area with a diameter of nearly ½ in. The skin was thickened in this region, but there was no blubbery tissue characteristic of elephantiasis. The spermatic cord was attached to its upper end posteriorly.

FIG. 171.—Showing: 1, Oblique and transverse section of adult female filaria containing numerous micro-filariæ within the uterus; 2, Eosinophil granulation tissue surrounding the dilated lymphatic. ($\frac{1}{12}$ × 2 Zeiss.)

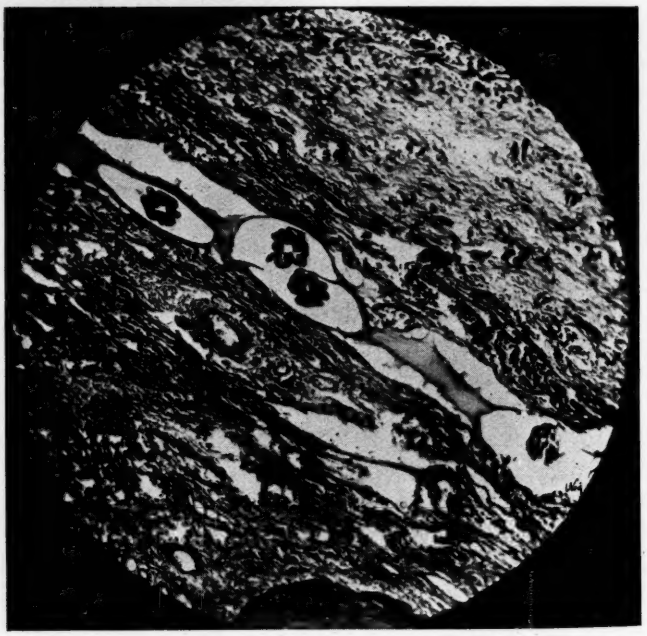

FIG. 172.—Showing transverse section of the adult filaria, with marked fibrosis and round-cell infiltration. ($\frac{2}{3}$ × 2 Zeiss.)

On transverse section through the adherent skin, the surface presented a whitish fibrous zone round the periphery, being ½ in. thick in some places. The vaginal sac was completely obliterated. The body of the testis and what appeared to be the epididymis were embedded in a connective-tissue matrix. The former

appeared as a lenticular area of greyish colour having been compressed from side to side, but the latter presented a rounded homogeneous gelatinous area of a darker colour, having a diameter of $1\frac{1}{4}$ in. In the cross-section the epididymis appeared to be the larger of the two (*Fig.* 170).

2. *Microscopic Appearances.*—

a. Testis.—The sections through the body of the testis showed scattered areas of round-cell infiltration with a varying number of plasma cells and fibroblasts in the interstitial tissues and in the neighbourhood of the seminiferous tubules. Eosinophils were absent throughout. Atrophy of the tubular epithelium and fibrosis were noted near the periphery, under the tunica albuginea. No endarteritis was noticed.

b. Epididymis.—This presented an interesting picture. It was difficult to identify its structure because the region of the epididymis was occupied by a circumscribed mass of necrotic material which had undergone hyaline degeneration. But sections of degenerating adult filariæ could be identified. This area was surrounded by a zone of round-cell infiltration with some admixture of plasma and eosinophil cells and foreign-body giant cells. Finally, there were concentric rings of fibrous tissue. This picture resembles that of caseating tubercle, but no tubercle bacilli could be demonstrated. Blood-vessels did not show any endarteritis or perivascular infiltration.

c. Tunica albuginea.—Anterior to the body of the testicle several transverse and oblique sections of adult female filariæ (*W. bancrofti*) could be seen, and numerous embryos were contained within the uterus of the parent worm. The smooth cuticle of the latter could be identified in some sections and the sheaths of the embryos in the others. The worm was placed within dilated lymphatics and in some areas it was surrounded by a well-stained zone of granulation tissue, infiltrated with eosinophil and plasma cells (*Fig.* 171). But the inflammatory reactions were not seen in all sections. No male worm could be identified, although it is usually coiled up with the female worm (*Fig.* 172).

d. Vaginal sac.—This was completely obliterated. There was a sort of fibrous capsule surrounding both the testis and the epididymis, formed by dense connective tissue (*see Fig.* 170).

e. Spermatic cord.—The vas deferens did not show any gross lesion, but dilatation of the lymphatics was well marked.

Note.—Sections were stained for bacteria in tissue by modified MacCullam's method, but no organisms were seen; neither was the *Treponema pallidum* seen in sections stained by modified Levaditi's method.

COMMENTARY

In the differential diagnosis of this case the following conditions had to be considered: (1) New growth of the testicle; (2) Diffuse tertiary syphilitic orchitis or gumma; (3) Hæmatocele; and (4) Epididymo-orchitis of filarial origin.

The insidious onset, tardy rate of growth, history of venereal disease, moderately positive Wassermann reaction, and firmness in consistency of the swelling were points in favour of a diffuse syphilitic orchitis rather than a gumma. The most important points against it were the presence of testicular sensation, lymphangiectasis of the spermatic cord, and the history of two previous attacks of pain in the testicle with successive increase in size. These points were rather in favour

of a filarial complication. On the same grounds, and in the absence of any history of trauma, the possibility of the hæmatocele was excluded. The therapeutic test for syphilis was given a trial and potassium iodide was also administered in big doses. In spite of energetic antisyphilitic treatment, no improvement was noticed. Clinically, the question of malignancy in such an enlargement of the testicle could not be settled. Therefore the differential diagnosis was narrowed down to two conditions—namely, a new growth and a testicular enlargement of filarial origin.

Some of the important clinical features may be emphasized here. The testicle was adherent to the scrotum anteriorly, presenting a small fluctuating area, through which about a drachm of sterile necrotic fluid was evacuated. During the patient's stay in the hospital for four weeks, the course of the disease was apyrexial. The blood report showed an eosinophil count of 2 per cent, but no definite cause could be discovered to explain it. The blood was not examined again for the microfilaria because it was decided to remove the testicle by operation, and because, in my experience, the presence of microfilaria in the peripheral blood is a test on which much reliance cannot be placed. Brug[1] even says that "during an attack of lymphangitis all microfilariæ disappear from the blood and it seems reasonable to explain this by the death of microfilariæ and perhaps of the adult worm." The complement-fixation test is of value, especially after an attack of lymphangitis. Unfortunately, this test could not be done in the hospital.

SUMMARY

1. A case of an unusual and chronic enlargement of the testicle, with a very interesting clinical history, has been described.

2. The testis and epididymis, which is converted into a necrotic mass, are embedded in a connective-tissue matrix, surrounded by a thick fibrous capsule, obliterating the vaginal sac.

3. Microscopically, sections of adult female worms (*W. bancrofti*) and numerous microfilariæ, contained within the uterus, are seen in the tunica albuginea. Degenerating adult filariæ are also seen in the epididymis.

4. No evidence of secondary pyogenic infection could be adduced. The conclusion is reached, therefore, that the adult filaria is the real or essential cause of the pathological changes in the testicle.

5. The condition has been described under the name of chronic epididymo-orchitis or fibrosis of the testicle of filarial origin.

I wish to express my gratitude to Lieut.-Colonel K. S. Thakur, I.M.S., Surgeon-Superintendent of the Howrah General Hospital, and Lieut.-Colonel R. N. Chopra, I.M.S., Officiating Director of the Tropical School of Medicine, for their kindness in giving me every facility for my work. My best thanks are also due to Dr. R. Sen Gupta for his help with the histological specimens, and to Professor C. C. Bose, Dr. D. N. Banerjee, and Dr. S. Sundar Rao, for the examination of the slides and for the preparation and study of serial sections.

REFERENCE

[1] BRUG, S. L., "Filariasis and Elephantiasis", *Nederl. Tijds. v. Geneesk.*, 1932, June 4, 2772. (Ext. *Trop. Dis. Bull.*, 1932, Nov., 767.)

TWO CASES OF OSTEOGENESIS IMPERFECTA WITH BLUE SCLEROTICS IN NATIVES OF INDIA

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The association of osteogenesis imperfecta (idiopathic osteopsathyrosis) with blue sclerotics has long been known, and according to Jones and Lovett an hereditary factor is present in 15 per cent of cases. The writer had never met with a case during twenty-seven years service in India, nor can any reference to its occurrence in this country be found in such literature as it available here. The admission to the Medical College Hospital, Calcutta, of two children suffering from this condition within the same week, in both of which the hereditary factor in the coloration of the sclerotics could be demonstrated, seems of sufficient interest to be placed on record.

Case 1.—A Bengali boy, aged 10, admitted on Aug. 28, 1933. The father was perfectly healthy in all respects. The mother was said to have been weak and sickly up to the age of 12 and to have suffered from fits of unconsciousness supposed to be epileptic in nature. These ceased as she grew up, though she was still of a neurotic temperament and suffered from palpitation of the heart. She had a miscarriage before the birth of this boy and another one subsequently, after which a second healthy boy was born. There are no other children. With some difficulty she was persuaded to come and see me at hospital, and, as I expected, she had well-marked blue coloration of the sclerotics. She was a well-developed woman, apparently in excellent health with regular features and of a very light brown complexion, the combination of which with the blue sclerotics presented (to European eyes) a very attractive picture. She brought her younger son with her and he also had the same blue coloration of the sclerotics, but had never sustained any fractures and was normal in all respects. No history of blue sclerotics or of fractures in her parents could be elicited.

The father said that the patient had always been a weakly child and had suffered from diarrhœa and irregular fever in infancy which had been diagnosed and treated as rickets. He had sustained no fewer than seven fractures between 1923 and 1927, the first at the age of three months, and all following slight violence—namely, twice of the left femur, twice of the right femur, once of the right tibia, and twice of the left forearm. The present admission was for a fracture of the right radius and ulna in the lower third. The fractures all caused only slight disability and united readily with simple splinting. From the appearances in some of the radiograms it would appear probable that several of them were greenstick fractures. The patient had lately suffered from attacks of nose bleeding. Except that the chest was rather flattened and the abdomen protuberant, the child was well developed and all the organs were healthy. There was no deformity of the skull, such as is described as occurring in severe cases, nor any deafness. In the lower third of

the right leg there was a curvature of the tibia with convexity forwards and slightly outwards at the site of an old fracture. The blood calcium was 10·5 mgrm. per cent. Wassermann reaction negative.

Fig. 173 shows the blue colour of the sclerotics very well, in striking contrast with the dark skin and brown irises. Radiograms were made of the whole skeleton. The skull showed a curious fine mottling of the bones of the vault, producing a

FIG. 173.—*Case* 1. Drawing showing the blue colour of the sclerotics.

spongy appearance. The right forearm showed the fracture of the radius and ulna for which the patient was admitted (*Fig.* 174). The right femur showed decalcification with bowing and some attempt at buttressing on the inner side, the result of the old fracture. There was considerable thinning of the compact layer in parts unaffected by the process of union of the fracture. The left femur, which also sustained a fracture, showed similar appearances. The right leg showed a bending of the tibia and fibula which somewhat resembled the appearances seen

in the later stages of rickets, but the epiphysial lines were clean-cut, showing no signs whatever of rickets, and the bony thickenings were not confined to the concavity of the curves, but affected both sides of the shafts and were evidently due to the callus laid down at the site of a fracture, which was probably of the greenstick type. The other bones all showed general decalcification and lightness of structure, in some cases with an appearance of longitudinal striation which radiologists describe as of frequent occurrence in this disease.

The fracture was reduced under anæsthesia and put up in plaster-of-Paris. It united readily in the normal time, and the patient was discharged with a good result.

FIG. 174.—*Case* 1. Right forearm.

Case 2.—An Anglo-Indian (Eurasian) girl, aged 10, admitted on Aug. 25, 1933, with a fracture of the left femur. Her mother, who was dead, was said to have had blue sclerotics; the father I did not see, but the stepmother brought up for my inspection the younger brother and sister of the patient, aged about 8 and 9 respectively, who both had blue sclerotics, though not so marked as in this patient. Neither of these children had ever had any fractures. The history of the previous fractures was rather vague; all we could obtain was an account of a slight injury to the left ankle some months before, which was not recognized as a fracture, though the radiograms which we took clearly showed a recently united fracture.

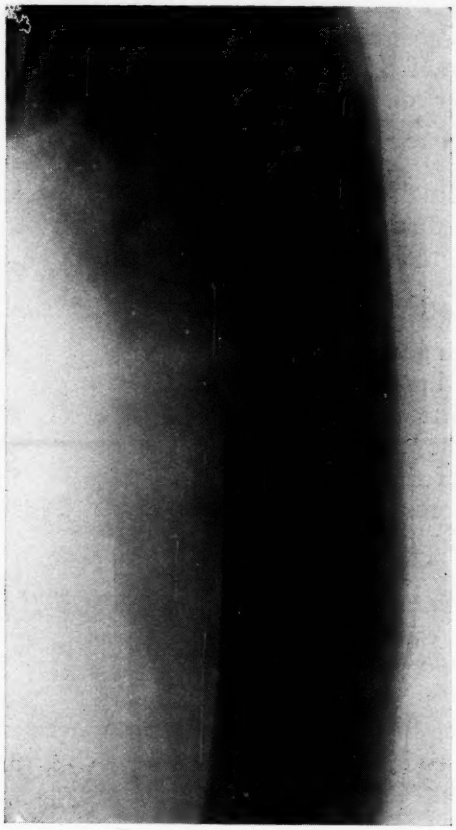

FIG. 175.—*Case* 2. Left femur.

The child was healthy in all respects and well developed. The blood calcium was 10 mgrm. per cent.

The radiogram of the injury (*Fig.* 175) showed a spiral fracture in the middle third of the left femur. This was treated by Hamilton Russell's method of extension, and *Fig.* 176 shows the result six weeks later—good callus formation in perfect position and an excellent clinical result, as is usual in these cases.

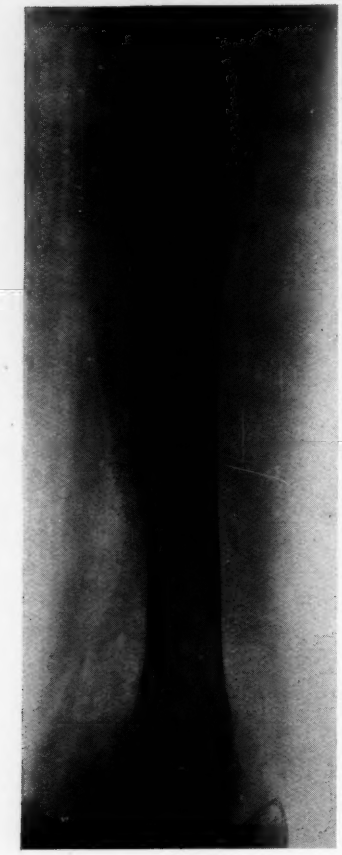

FIG. 176.—*Case* 2. Left femur six weeks after treatment.

The other radiograms showed the same general decalcification and lightness of the compact bone as in *Case* 1, but not to such a marked degree. *Fig.* 177 obviously shows a recently united greenstick fracture of the left tibia, though the history records only a sprain, and the curvature of the bone was evident clinically. In the right leg there was a thickening in the lower third of the fibula and a slight inward bend of the tibia, evident in the radiogram though not clinically, probably due to weight-bearing during the healing of an undiagnosed fracture. The skull showed a mild degree of the same fine mottling observed in *Case* 1.

DISCUSSION

Both the cases appear to be examples of the more common type of the disease, seen in older children and adolescents, with thinned out cortex, but no special alteration in internal texture of the bones; though *Case* 1 showed in the skull the honeycomb structure associated with the more severe type, in which general softening of the bones leads to bending rather than breaking; but the rest of the skeleton showed only a slight indication of this condition in the shape of a longitudinal striation of some of the long bones, and the radiograms showed that the curvatures of the bones were all due to old fractures. There was no question of rickets playing any part in the causation in either case, as the characteristic radiological changes of that disease were entirely absent and the epiphyses in both cases were perfectly normal.

FIG. 177.—*Case* 2. Left tibia and fibula.

There is a tendency in some cases for the skeleton to become stronger and the fractures less frequent after puberty, and it appears likely that such a mild case as *Case* 2 will outgrow the disease, but *Case* 1 was a more severe type and in this patient the prognosis is not good.

Both these cases were sent to Lieut.-Colonel Kirwan, F.R.C.S.I., I.M.S.,

Professor of Ophthalmology, Medical College, Calcutta, for his opinion on the eye condition, and a note by him on the subject of blue sclerotics is appended.

" Although many cases of blue sclerotics have been reported in ophthalmic literature, the condition is uncommon in India, and during the six and a half years I have been Professor of Ophthalmology in the Medical College, Calcutta, I have seen only two cases: one was in an Anglo-Indian girl and the other in a Bengali boy.

" Congenital blue sclerotics are characterized by abnormally thin scleras extending from the corneal margin as far back as can be seen, and are accompanied by a failure in the development of the connective tissues. This condition is frequently accompanied by fractures of the long bones, dislocations and sprains of the joints, deafness due to otosclerosis, small stature, and dental affections. The thinness of the sclerotics is hereditary in nature and it is usually possible to get histories of its occurrence in several successive generations. It is transmitted by either male or female through affected persons only, and is present, according to Kunii,[1] in half of the relatives.

" The etiology of the condition is still open to doubt. Two theories are brought forward—one that it is due to an increased transparency of the sclera owing to the lack of fibrous tissue and lime salts, and the other that it is due to an increase in the pigment in the cells of the sclera. Some others consider that it is due to poverty of the mesodermal layers, whilst others dispute this hypothesis, as often ectodermal structures are affected and blue scleras have been found in many congenital defects of the eye both of mesodermal and ectodermal origin."

REFERENCE

[1] KUNII, *Zeits. f. Augenheilk.*, 1930, July, 328.

CHOLECYSTITIS WITHOUT STONE

AN INVESTIGATION OF 264 OPERATED CASES FROM THE CLINICAL, RADIOLOGICAL, AND PATHOLOGICAL ASPECTS. AN ATTEMPT TO DETERMINE THE FACTORS OF SERVICE IN ESTIMATING PROGNOSIS *

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SYNOPSIS

Introduction

Historical note

Is prognosis after cholecystectomy better in cholelithiasis or in cholecystitis without stone?

Is the case-history or the histology of the gall-bladder the more reliable guide in estimating prognosis after cholecystectomy?

The Present Investigation (264 Cases)

Method of selection of cases

Survey of pathological material

The clinical results after cholecystectomy

Statistical analyses

1. The relation of local conditions around gall-bladder to clinical end-result
2. The relation of the pre-operative history to the clinical end-result
3. The relation of microscopic pathology to the clinical end-result
4. The relation of cholecystographic findings to pathological changes in the gall-bladder
5. The relation of cholecystographic findings to the clinical end-result

General Conclusion

INTRODUCTION

It is only fifty-two years since Langenbuch performed the first cholecystectomy (1882), thus introducing an operation which has become one of the most frequent in surgery. Its widespread application is an even more recent development, and great changes in the indications for it have taken place even in the last few years. The early practice of gall-bladder surgery is exemplified by a series of 12,000 cholecystectomies by German surgeons collected and published in 1923 by Hotz. The figures referred to a period when cholecystectomy was a definitely hazardous procedure, and so the principal point of interest was the mortality rate, which averaged 10 per cent. When ultimate prognosis was considered, recrudescence of pain was the usual expectation in 25 per cent of cases and minor complaints were lightly regarded. Hotz felt this to be an unsatisfactory state of affairs, and largely attributable to the respect accorded to the teaching of Kehr (1913)—that symptoms

* This work was done during tenure of a Rockefeller Foundation Travelling Fellowship in Surgery, 1932–3.

will subside spontaneously in 80 per cent of gall-stone cases, and accordingly operation should be reserved for the remaining 20 per cent; in all of these it should be regarded as a necessary and life-saving measure, but the others should not be subjected needlessly to the risk, even though slight, of a gratuitous operation. Hotz challenged these conservative views, and advocated operation immediately the diagnosis of gall-stones had been made, for, in the relatively young, without degenerative changes in vital organs, operation would carry little risk (mortality about 4 per cent), and a good ultimate prognosis could be given. On the other hand, in cases where the disease had been allowed to drag on to old age, risks were so high, and recrudescence of symptoms so frequent, that one would hesitate to interfere.

It will be noted that in the period covered by Hotz's review biliary surgery was practically limited to cases of gall-stones, but since that day its scope has widened greatly. The introduction of cholecystography by Graham and Cole in 1924 opened new avenues of approach to the study of biliary physiology and pathology, stimulated interest in gall-bladder surgery, and led undoubtedly to wide extension of its practice, for 'cholecystitis' was diagnosed at an earlier stage, and many gall-bladders were removed that previously might have been left *in situ*. In 1927 Judd from his wide experience stated that "The number of operations upon the gall-bladder has been greatly increased since the general employment of the Graham-Cole method in making the diagnosis". In the following year Hirsch and Taylor proposed the admonitory query, "Are we approaching an era similar to that happily passing in reference to the appendix, when the gall-bladder is to be removed on slight pretext?" This important question can be answered only by critical analysis of the end-results in a great number of cases subjected to cholecystectomy, and it is part of the object of this paper to contribute some information of this kind.

Much of the increase in the employment of cholecystectomy may, of course, be attributed to reduction in operative mortality. The decision to perform any operation of election is made only when it is estimated that the probability of ultimate benefit sufficiently outweighs the operative risk. Operative mortality in biliary surgery has been enormously reduced in recent years through the application of new knowledge of liver physiology, and, as an aid in assessing the risks of operation, the use of tests of liver function (e.g., Graham, Cole, et al., 1926), correlated with appropriate pre-operative treatment. A reasonable degree of integrity of the metabolic and detoxifying activities of the liver is essential for the safe performance of any major operation, especially under general anæsthesia, but since disease of the gall-bladder shows an especial tendency to lead to destructive hepatic lesions, it is all the more necessary in this branch of surgery to determine, before embarking upon an operation of election, that the functional capacity of the liver is satisfactory. By the routine use of these principles and methods, Graham has reduced his operative mortality from 6 per cent to the extraordinarily low figure of 0·4 per cent (1931).

The risk of attack upon the gall-bladder, therefore, has been to a great extent eliminated, and interest has tended to move away from mortality statistics, bacteriology, and pathology, and to be focused upon end-results and theories of gall-bladder function, regarding all of which there has been most voluminous but extraordinarily conflicting writing. Thus writers are far from agreement upon the

apparently simple question of *whether the prognosis after cholecystectomy is better in cholecystitis without stone or in frank cholelithiasis.* Hartmann and Petit-Dutaillis (1922), Alvarez (1923), Deaver (1925), Zink (1926), Deaver and Bortz (1927), and Connell (1928) have all published their findings that results are better in the former condition, and explain these by the assumption that cholecystitis without stone represents the earliest stage of gall-bladder disease and that when the stage of cholelithiasis is reached there have developed, in a large proportion of cases, secondary lesions in other viscera, which persist after cholecystectomy and maintain symptoms. On the other hand, Flörcken (1923), Gundermann (1924), Seuleberger (1925), Hitzrot and Cornell (1926), Müller (1926), Lahey (1927), Young (1928), Schöndube (1928), Feinblatt (1928), Ross (1932), and Stanton (1932) all found that the clinical results are better in cholelithiasis, and argue that many stoneless gall-bladders removed at operation have not in fact been the cause of the symptoms with which they have been libelled.

It would be strange were there no middle position in this moot question, and indeed there is—namely, that adopted by Hueck (1928) and by Judd and Priestley (1932), who could find no significant difference in the results achieved by cholecystectomy in cholelithiasis and in cholecystitis without stone.

In an attempt to discover with which of the large opposing schools the balance of truth may lie, an analysis has been made of practically all of the statistics of the end-results after simple cholecystectomy published during the last ten years, representing rather over six thousand cholecystectomies of wide geographic distribution.

The evidence obtained may be summarized by saying that: "*The experience of a large number of surgeons in the past has shown that cure or improvement after cholecystectomy may be expected in nearly* 90 *per cent of cases of cholelithiasis and in rather over* 80 *per cent of cases of cholecystitis without stone*".

Is Greater Reliance to be Placed upon the Case History or upon Pathological Examination in Assessing Prognosis? It is interesting to study the recoil in recent years from the pathological point of view toward the clinical in gall-bladder diagnosis.

Criticizing Alvarez' paper in 1923, MacCarty stated definitely, "I do not believe in removing a gall-bladder on a history", while in 1924, drawing a parallel with the operation of gastro-enterostomy, Judd and Burden began an article with the dictum, "Removal of the gall-bladder on the basis of symptoms and clinical history in the absence of a local lesion invites discredit on the judgment of the surgeon and on the operation". In the following year Judd stated, "Operations based on clinical symptoms alone are likely to fail". In the same place, however, when discussing the stoneless gall-bladder he said, "In the presence of colic the diagnosis is certain, but much uncertainty attends attempts to diagnose chronic cholecystitis in the absence of colicky pain. As a general rule operative procedures must be based on a tangible lesion found at operation and not on physiologic changes or clinical symptoms." Finally, in 1927, Judd formulated his opinion as follows: "While one hesitates to remove a gall-bladder in the absence of definite pathology, if the gall-bladder is not removed in these clinically definite cases, symptoms will continue. If it is removed the pathologist generally finds the changes of chronic cholecystitis." This last fact loses some of its importance, however, when it is remembered that Carman, MacCarty, and Camp (1924) found only 17 normal

gall-bladders in a consecutive unselected series of 5000 obtained at autopsy. Clearly it is unlikely that more than a small proportion of these 'abnormal' gall-bladders had given rise to trouble during life, and the clinical value of emphasizing such slight changes in the histology of the gall-bladder would seem therefore to be doubtful. Schmieden (1921) published an account of his views on dyskinesia of the biliary tract, and stated that in one year he had removed fourteen stoneless gall-bladders, with cure of symptoms of biliary colic in all. He concluded that, even in the absence of pathological changes, provided always that symptoms were severe, cholecystectomy would achieve good results in these cases of dyskinesia; this is the direct reverse of the standpoint, quoted above, adopted by Schöndube. Deaver and Bortz (1927) concluded that the most important factor in making a diagnosis of gall-bladder disease is the clinical history. In the same year Lahey stated, "If operation is done for a definite chain of symptoms unrelieved by medical treatment, then the normal appearance of the gall-bladder would not deter one from removing it, for it may be a cholesterol gall-bladder".

Young (1928), reviewing a large series in which the diagnosis was made before cholecystography was available, found that, generally speaking, those cases in which there is not a definite history of biliary colic are the least likely to be improved by cholecystectomy. "The only justification for operation on the biliary tract should be well-established clinical and laboratory evidence that the gall-bladder is at fault, and having made that diagnosis, it should be removed whether or not it seems diseased to the examining hand." Very recently Stanton (1932) has re-asserted his conviction of 1927 that "The only reliable guide is the presence of attacks of definite gall-bladder colic, and if the surgeon is sure of such a history, he can confidently remove the gall-bladder even in the absence of gross pathology".

There is a further group of symptoms commonly ascribed to gall-bladder disease and occasionally referred to in surgical text-books as those of the pre-calculous stage of cholecystitis—flatulent dyspepsia, food-selection (inability to tolerate certain articles of food, especially fats, certain vegetables such as cabbage, or raw fruits), and constipation. Some doubt exists, however, regarding the diagnostic significance of these symptoms.

It is clear from the above review that the majority of surgeons have come to regard biliary colic as a symptom which definitely implicates the gall-bladder, although the condition may be functional and not organic. Further, many hold the opinion that, if colic has occurred, a satisfactory outcome from cholecystectomy may be practically guaranteed. In fact, in estimating prognosis, this symptom is considered to be of greater importance than the pathological changes that may be present in the gall-bladder.

A smaller number of writers have attributed an almost equal significance to the less prominent symptoms—flatulent dyspepsia, food selection, and constipation—which go to complete the syndrome regarded as characteristic of gall-bladder disease.

It would be possible to continue this balancing of conflicting beliefs and published statements regarding practically every important point in biliary surgery, but enough has been said to show that there is still much need for detailed investigation and accurate observation.

THE PRESENT INVESTIGATION

This investigation was undertaken at the kind suggestion of Dr. Evarts A. Graham, Professor of Surgery at Washington University Medical School, St. Louis, Mo., U.S.A. Its principal object is to discover the end-results after cholecystectomy in cases of cholecystitis without stone.

METHOD OF SELECTION OF CASES

The material for the survey consists of the cases in which, during the ten-year period 1922–31, cholecystectomy was performed by the surgeons on the staff of Barnes Hospital, St. Louis. The investigation concerned all cases of cholecystitis without stone, and all cases of cholesterosis of the gall-bladder. The cases in which cholesterosis was complicated by the presence of stone were also included.

During the period in question appendectomy was performed routinely at the same time as the cholecystectomy, and a small piece of liver removed for microscopic examination (biopsy), but no case has been considered in which there was a more extensive surgical procedure, or in which the stoneless condition of the gall-bladder was due apparently to a previous cholecystostomy. The adoption of these uniform standards of treatment makes possible a fairly accurate analysis of end-results in their relation to variations in clinical history, microscopic findings, and radiological data.

A letter of inquiry was sent to each patient, and in cases where the family physician was known, his opinion in addition was sought. The letter to the patients contained six questions :—

1. Do you consider yourself cured, improved, or unimproved by your operation ?
2. Do you have any indigestion now ?
3. If so, is this indigestion of the same character as that which you had before ?
4. If not, will you state your principal complaints, such as pain, bloating, nausea or vomiting, constipation, belching, jaundice, sour mouth ?
5. Is it necessary for you to omit certain kinds of food from your meals ?
6. If so, what kinds—fried foods, uncooked fruits and vegetables, etc. ?

To the majority of those expressing themselves as unimproved, an invitation was sent to come for examination, and in a few it was found that definite improvement had in point of fact been achieved, but in the greater number the replies to the questionary proved reliable.

SURVEY OF PATHOLOGICAL MATERIAL

In order to arrive at a uniform assessment of the gall-bladder lesions under consideration, the pathological material, all of which is preserved in the Department of Surgical Pathology, Washington University, was reviewed. The following brief paragraphs are introduced in order to define accurately the terms of classification. The number of accompanying photomicrographs has been reduced to a minimum and these represent merely a few examples illustrative of the conditions described.

INTERPRETATION OF THE TERMS OF PATHOLOGICAL CLASSIFICATION

The Gall-bladder with Minimal Lesion (*Figs.* 178, 179).—The gross specimen is relatively thin-walled and contains well-coloured clear bile. Microscopically, the mucosa is plicated to a degree depending upon the state of distension and the site of origin of the specimen (the mucosal folds being taller near the neck). There is often a considerable amount of lysis of the columnar epithelium, due to action of the bile-salts after ligation of the cystic artery. The subepithelial layer consists of rather dense poorly cellular fibrous tissue, forming a delicate core for each fold. This layer contains a few lymphocytes. The muscularis is a thin sheet of interlacing strands of fine smooth fibres, rather intensely eosinophil. It is rare for the muscular tunic to be penetrated by pouchings of the mucosa, but on occasion one finds a pocket of the latter escaping through an hiatus in the muscularis, and forming a dilated vesicle in the subserous coat, without any accompanying evidence of recent or old inflammation. The amount of subserous fibrous and elastic tissue varies, but one should be able to distinguish separate wavy bundles of mature collagen fibres. A tendency to dense lamination is evidence of previous definite inflammatory episodes, after which it is rare for restitution to be so complete that the gall-bladder lesion may be termed 'minimal'.

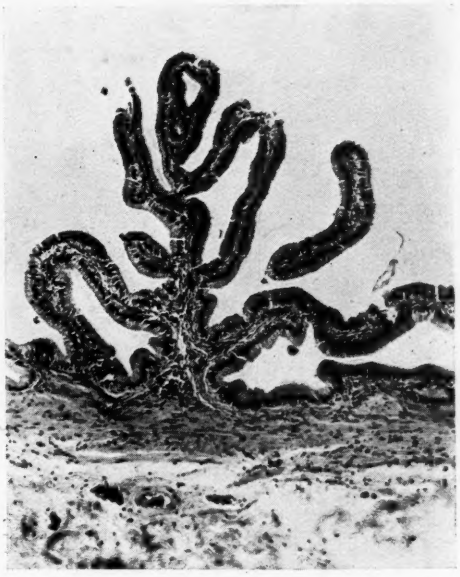

FIG. 178.—Minimal lesion. Specimen from body of gall-bladder. Complex plicate arrangement of mucosa. Plica shows extremely delicate core of mature vascular fibrous tissue with moderate lymphocytic infiltration. Thin well-defined muscular layer. (× 50.)

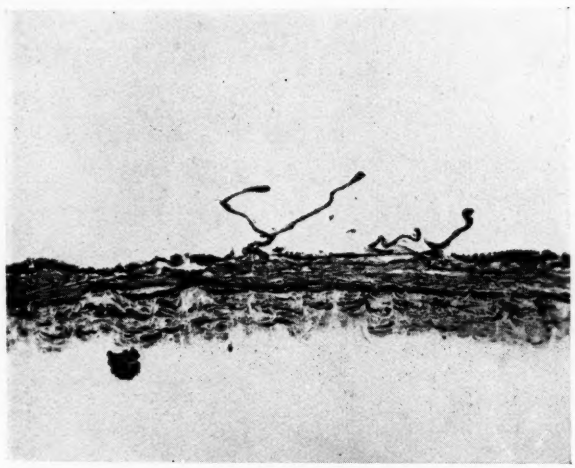

FIG. 179.—Minimal lesion. Almost complete lysis of lining epithelium due to slight delay in fixation. In the presence, however, of the thin muscular coat, delicate plical cores, and normal subserous layer all free of inflammatory infiltration, this extreme lysis is merely additional evidence that in life there has been little departure from normal in the gall-bladder or in its content. (× 50.)

Chronic Catarrhal Cholecystitis (*Figs.* 180, 181).—The most prominent characteristic of this condition is mucosal œdema, with clubbing of the tips of the plicæ. In addition, lymphocytic infiltration is increased, not only in the mucosa but also in the outer coats. The epithelium is better preserved than in gall-bladders more nearly normal, because of

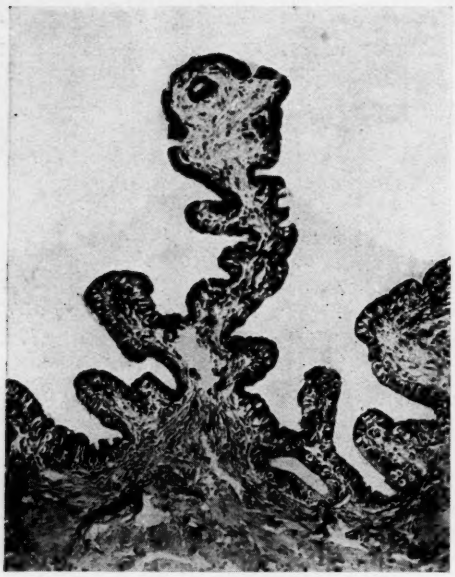

FIG. 180.—Chronic catarrhal cholecystitis. Typical specimen. Marked œdema with clubbing of ends of plicæ. Some muscular thickening and increase of fibro-cellular tissue of mucosa. (× 50.)

FIG. 181.—Chronic catarrhal cholecystitis. Advanced case with great muscular thickening and formation of muciniferous glands of 'gastric' type. The lysis of the superficial epithelium is an artefact. (× 50.)

FIG. 182.—Chronic fibrous cholecystitis. Enormous thickening and hyaline change in muscular layer. Mucosal plicæ more or less absent. Epithelium closely applied to muscle bundles, between which crypts herniate. (× 50.)

FIG. 183.—Chronic fibrous cholecystitis. Extreme muscular hypertrophy and crypt formation, with inflammatory infiltration around crypt. The superficial lysis is an artefact. (× 50.)

course the bile is less concentrated. The epithelial cells tend towards cubical type, and muciniferous elements may be increased in number either by multiplication of the goblet-cells normally present or by new-formation of actual mucous glands in parts other than the neck, where they are normally present. To these abnormal glandular structures the term 'gastric glands' is sometimes applied. The muscular coat is moderately thickened. Mucosal crypts penetrating the muscular coat are slightly more common than in gall-bladders showing minimal lesions.

Chronic Fibrous Cholecystitis (*Figs.* 182, 183).—It is rare for the stoneless gall-bladder to be the seat of this advanced lesion, which develops usually as a result of repeated attacks of obstruction by stone. The mucosa is degenerate, with cubical epithelium set upon squat plicæ of rather dense fibrous tissue into which muscular bundles often project. The close application of the epithelium to the muscularis, and the marked tendency for the formation of diverticular epithelial crypts extending completely through the muscular coat, are among the prominent features of the condition. When fully developed the crypts form large dilated simple glandular pockets, surrounded by a thick layer of new-formed fibrous tissue which shows a degree of inflammatory infiltration dependent no doubt upon the presence or absence of infection, and the time which has elapsed since the last obstructive attack. In the intervening areas the muscular layer is greatly thickened, owing in part to a sort of hyaline swelling of the individual fibres, which in section may appear like empty shells, and in part possibly to actual increase in their number. The subserous coat shares in the general thickening and often there is marked endarteritis of the larger vessels.

Cholesterosis of the Gall-bladder (Strawberry Gall-bladder) (*Figs.* 184–186).—These are the names given to a very common condition in which the gall-bladder mucosa shows a yellow stippling owing to lipoid deposits situated principally at the tips of the plicæ. Its frequency may be appreciated from the fact that Mentzer (1925) found some degree of cholesterosis of the gall-bladder in 38 per cent of all cases coming to autopsy at the Mayo Clinic. Regarding its ultimate nature, however, there is on many points the most acute divergence of opinion. Accordingly it will be considered in detail in a later paper, and meanwhile only a brief description will be given. Essentially it consists in the accumulation of doubly refracting cholesterol esters and neutral fats principally in two sites—namely, in the lining epithelium and in macrophages in the connective tissue of the mucosa. The deposit is patchy and forms bright yellow flecks visible to

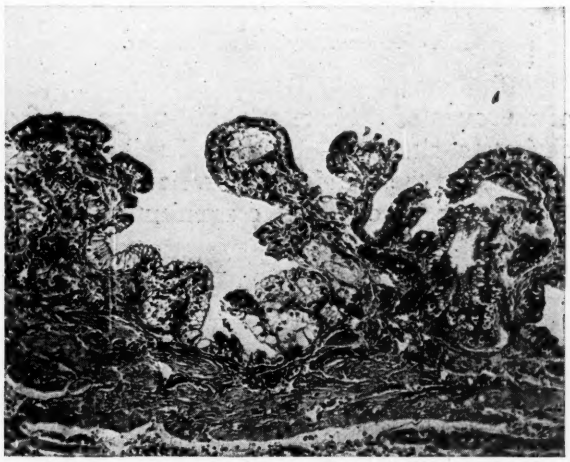

FIG. 184.—Cholesterosis. Massive lipoid deposit confined to the lining epithelial cells. In some of these the lipoid is so abundant that they have taken on the histological character of 'foam-cells'. Some lymphocytes in all coats, and possibly slight muscular thickening, but no unequivocal inflammatory signs. (× 50.)

the naked eye, sometimes slender and scanty, sometimes filling each mucosal fold so that the gall-bladder appears to be lined with a thick soft fabric woven of coarse golden waxy threads. Quite frequently yellow morular polypi hang by slender stems, and in some cases these polypi may be the sole sites of gross lipoid deposit. The subserous coat often contains an unusual amount of fat. In about a third

FIG. 185.—Cholesterosis. Interstitial cholesterosis and pedunculation in a gall-bladder showing no inflammatory signs whatever. (× 50.)

FIG. 186.—Cholesterosis. Lipoid deposit in this section confined to a single stromal cell of a gall-bladder showing most extreme degree of inflammatory infiltration and thickening. (× 50.)

of the cases of cholesterosis, gall-stones are found, and they are almost always of cholesterol-rich type—cholesterol solitaires and mulberry stones.

During the decade under review, cholecystectomy was performed on 262 cases which may be classified conveniently into five categories of gall-bladder lesions.

Table I.—NUMERICAL DISTRIBUTION OF LESIONS UNDER CONSIDERATION. PATHOLOGICAL MATERIAL AVAILABLE IN 262 CASES

	TRACED	UNTRACED	TOTAL
Minimal lesion	57	46	103
Cholesterosis	33	13	46
Chronic catarrhal cholecystitis ..	53	30	83
Chronic fibrous cholecystitis ..	5	4	9
Cholesterosis with stone ..	18	3	21
TOTALS	166	96	262

In two additional cases the pathological material was not available. The number of cases in the various pathological categories are given in *Table I*, which shows also that it has been possible to trace the clinical outcome in 166.

It will be seen that, on histological grounds, rather more than a third of the cases have been termed 'minimal lesion'. This demonstrates that the present series embraces a considerable proportion of cases of quite 'early' gall-bladder disease. It is fairly certain that, had a specific search for cases of cholesterosis been made in the early years, more would have been found. In checking the pathological material a few cases were discovered which previously had been overlooked, but, generally speaking, inspection of the fresh specimen will discover degrees of lipoid infiltration difficult to identify histologically without special methods.

THE CLINICAL CONDITION AFTER CHOLECYSTECTOMY FOR CHOLECYSTITIS WITHOUT STONE

Of a total of 264 cases suited for this study it was possible to examine the pathological material and also to ascertain the end-result in 166, 148 stoneless, and 18 cases of cholesterosis with stone. In assessing the post-operative state of a case as *well*, *improved*, or *unimproved*, the opinion of the patient on the matter has been the most important criterion. Now, if a patient has been subject to attacks of biliary colic, he will be delighted to be relieved of this, and will happily bear such minor distresses as flatulence and avoid certain foods which he finds are followed by discomfort. On the other hand, if the original symptoms have not been so severe, slighter residua will be a source of complaint. Thus it comes about that certain of the patients classed as unimproved have possibly no greater disability than have some who are designated 'well', yet this subjective method of classification appeared to be the most satisfactory.

Of the 149 *cases of cholecystitis without stone*, 44 (29·2 *per cent*) *were classed as cured*, 44 (29·2 *per cent*) *as improved, and* 53 (36·2 *per cent*) *as unimproved. There were* 8 *deaths.*

The series of 18 cases of cholesterosis complicated by the presence of stone is of course small, and cannot be regarded as an adequate control, in comparison with the stoneless cases; yet it is worthy of mention that none failed to be improved.

MORTALITY AFTER CHOLECYSTECTOMY FOR CHOLECYSTITIS WITHOUT STONE

That there should have been 8 deaths in this series of stoneless gall-bladder cases is surprising. Although *Table V* indicates an operative mortality of 5·4 per cent, this is misleading, for the mortality should of course be calculated on all the operations and not merely on the number of cases subsequently traced. The mortality so adjusted is 3·3 per cent, a low figure, but not lower than the average mortality for gall-bladder operations of every kind during the period, so that the absence of advanced pathological changes in a gall-bladder is not in itself evidence that cholecystectomy will be a procedure free from risk. It is clear that when there is little amiss with the gall-bladder, there is a greater chance that diagnosis may not have been accurate and that the symptoms may have been due to some other unsuspected cause, under which circumstances the operation can do little but harm. There is the further possibility that removal of a fairly healthy gall-bladder, which still retains a proportion of its normal function, may produce more violent systemic derangement, and hence be more dangerous, than removal of an effete organ.

The pathological condition of the gall-bladder in the 8 fatal cases was as follows. Minimal lesion 3, cholesterosis 1, chronic catarrhal cholecystitis 4.

From this preliminary survey, it has emerged that in cases of cholecystitis without stone treated by cholecystectomy we may expect an operative mortality of about 3 *per cent, cure of symptoms in* 30 *per cent, improvement in* 30 *per cent, and an unsatisfactory result in* 37 *per cent.*

It is clearly desirable that the operation of cholecystectomy should be withheld in this last group, and the remainder of this paper consists largely of various analyses of the results to determine if possible the characteristic features of cases favourable for cholecystectomy.

STATISTICAL ANALYSES OF CLINICAL, PATHOLOGICAL, AND RADIOLOGICAL INFORMATION, AND CORRELATION WITH ULTIMATE OUTCOME

Local Conditions Found at Operation in Relation to Prognosis

It was found that the cases of cholecystitis without stone could be divided on the basis of local appearances into two large groups, namely, those in which adhesions were limited to the neck and infundibulum of the gall-bladder, attaching it to the first part of the duodenum (*Series A*), and those in which the gall-bladder was more or less buried in adhesions (*Series B*). *Table II* shows the clinical end-results in these two series.

Table II.—The Relation of Local Pathology to Late Clinical Result after Cholecystectomy: 149 Cases of Cholecystitis without Stone.

Type of Case	Total	Well	Improved	Unimproved	Post-operative Death
A. Cases with adhesions limited to region of neck of gall-bladder ..	72	22 (31%)	12 (17%)	33 (45%)	5 (7%)
B. Cases with extensive adhesions more or less covering gall-bladder	77	22 (29%)	32 (41%)	20 (26%)	3 (4%)

It will be seen that of *Series A* approximately one half were cured or partially relieved of their symptoms, and of *Series B* 70 per cent. The majority of the poor results occurred in those cases with only slight signs of previous inflammation around the gall-bladder. Of these only half derived any benefit from the operation. It would be most valuable, however, were it possible to determine *before operation*—e.g., from study of the history—which case is likely to do well, and which to give a poor result. In an attempt to secure information which may be used in this way an analysis has been made in which the types of pre-operative symptoms are correlated with the end-results after cholecystectomy (*Table III*).

Clinical History and its Relation to Prognosis

As already mentioned, many authors maintain that cases with a history of biliary colic are practically certain to do well after operation while cases without such a history are likely to do badly. This statement is readily tested in the present series since the presence or absence of biliary colic makes a very clear-cut

division between two types. Biliary colic has been taken to mean pain of considerable severity, originating in the epigastrium and radiating backward, usually to the angle of the right scapula, although it is known that biliary pain does not always conform to this description.

Table III.—Correlation of Biliary Colic and Pathological Changes with End-results after Cholecystectomy in 140 Cases of Cholecystitis without Stone

Pathological Lesion Present	47 Cases with History of Biliary Colic			93 Cases without History of Biliary Colic		
	Well	Improved	Unimproved	Well	Improved	Unimproved
Minimal lesion	2	6	7	9	15	15
Cholesterosis	8	0	5	6	2	11
Chronic catarrhal cholecystitis	10	6	1	7	12	13
Chronic fibrous cholecystitis	1	1	0	1	2	0
Total of stoneless cases ..	21	13	13	23	31	39
Percentage well or improved	76			58		

Of the stoneless cases, 47 (33 *per cent*) *gave a history of colic, and of these* 76 *per cent were cured or improved by operation, while of the* 93 *in whom colic had not occurred, only* 58 *per cent had derived benefit from the cholecystectomy.* The prognosis, therefore, is distinctly better in the cases in which colic has occurred, though the difference between the two types is not extreme. The fact that a third of the cases of cholecystitis without stone had suffered from biliary colic is important, for it proves beyond doubt that this symptom is not always due to the presence of biliary calculi. On the other hand, it is probable that in the great majority of cases the symptoms of biliary colic arise as a result of obstruction of the outlet from the gall-bladder to the cystic duct. Clearly, therefore, whatever the ultimate basis of the symptoms, the latter are likely to be relieved by removal of the gall-bladder.

Conclusions derived from a more detailed analysis on the basis of the pathological subdivisions would necessitate much larger numbers. Accordingly the large percentage of improvement registered in those cases of cholesterosis and chronic catarrhal cholecystitis with a history of colic is merely pointed out without comment. Nevertheless it is interesting to recall the title of Moynihan's original article (1909) "A Disease of the Gall-bladder requiring Cholecystectomy". The six cases described came to operation for the relief of severe biliary pain, and the present series might easily have furnished a comparable group of six consecutive successes. The conclusion might then justifiably have been drawn that the symptoms of cholesterosis are often benefited by cholecystectomy, though to term it a lesion which requires cholecystectomy would possibly be unduly dogmatic.

Next to biliary colic, flatulent dyspepsia and food selection are the syndrome most generally held to incriminate the gall-bladder. Some authors are of the opinion that "it cannot be too strongly stated" that this is so, and that accordingly patients complaining of these symptoms will best be treated by cholecystectomy. This thesis can readily be submitted to the therapeutic test in the present series. Of the 167 cases which have been traced, 80 complain still of these symptoms.

Only 14 are known definitely to have been relieved by the operation, and a considerable number apparently have developed flatulence and food selection during the period since the operation. This does not, of course, indicate that the operation was responsible for the appearance of these minor symptoms, for it may well be that the mere passage of the years has brought upon some these gassy upsets and distaste for certain foods. The list of foods which prove harmful varies, but generally comprises fat, pork, fried food, raw fruit, and the wind-forming vegetables —cabbage, asparagus, and the legumes.

These findings emphasize the fact already stated that, in the present series, relief of pain was not invariably accompanied by alleviation of associated minor discomforts. It seems very doubtful, therefore, whether these symptoms of flatulent dyspepsia and food selection have their origin directly in the gall-bladder. It is more probable that they arise in some disturbance of motor function elsewhere in the alimentary tube, possibly at the pylorus or in the colon. They are unlikely to be relieved by cholecystectomy.

Microscopic Pathology and its Relation to Prognosis

From the surgical aspect, value attaches to separation of the various types of lesion which affect an organ only if it is possible thereby to foretell accurately the outcome of treatment—in other words, a correlation must be made between pathological change and prognosis, and this, in the case of the gall-bladder, has never been done. It is a natural assumption that, other things being equal, the more advanced the lesion present in such an organ, the more marked will the resulting symptoms be, and the greater the relief after its removal. The preliminary discussion, however, showed that many authorities in the field of biliary surgery believe that, with the advance of the morbid process in the gall-bladder, there develop almost constantly in other organs associated lesions which cause the outlook to be less favourable; accordingly they advocate operation early in cholecystitis, before these secondary changes have had time to occur. This implies that, if the gall-bladder is removed at a stage when pathological changes in its wall are at a minimum, results will be better than when the gall-bladder is markedly diseased.

Table IV.—Results of Cholecystectomy in 148 Stoneless Cases and 19 Cases of Cholesterosis with Stone

	Total	Well	Improved	Unimproved	Post-operative Death
Minimal lesion	57	11	22	21	3
Cholesterosis	33	14	2	16	1
Chronic catarrhal cholecystitis ..	53	18	17	14	4
Chronic fibrous cholecystitis ..	5	2	3	0	0
Cholesterosis with stone	19	6	13	0	0

It will be seen from *Table IV* that in the series of cases in which the gall-bladder was the seat of a minimal lesion, 58 per cent derived some benefit from the operation, though only a small proportion were relieved of all their complaints. Of the cases of cholesterosis, only half were benefited, but of the latter almost all professed to be completely cured. Of the cases classified as chronic catarrhal

cholecystitis, 67 per cent secured some benefit, and in the two final categories of more definitely diseased gall-bladders, none failed to be improved, though a fairly considerable proportion continued to have some complaints, generally flatulent dyspepsia, food selection, and constipation. The cases of cholesterosis with stone have been included in the table to serve as a control upon cases less definitely pathological.

To what Extent may Improvement be Attributed to the Associated Appendectomy?

Cases with only very slight pathological changes in the gall-bladder were improved after cholecystectomy to the number of 58 per cent. In evaluating such slight changes it is essential to determine how far the associated appendectomy was responsible for the benefit. As with the gall-bladder, so with the appendix, none is normal if importance is attached to minutiæ, but it has come to be believed that it is rare for an appendix to produce marked symptoms without the occurrence of obstructive or inflammatory attacks which leave behind very definite evidence in the form of well-marked thickening, particularly of the submucosa. *Table V* shows the distribution of the cases in which definite appendicitis was present, and also the clinical result of operative treatment upon the various categories of cholecystitis. The first numeral in each column represents the total number of cases in the category, the number in brackets indicates how many of these showed definite appendicitis.

Table V.—Association of Marked Chronic Appendicitis with Gall-bladder Lesions

State of Gall-bladder	Condition following Operation		
	Well	Improved	Unimproved
Minimal lesion	11 (2)	22 (5)	21 (8)
Cholesterosis	14 (5)	2 (1)	16 (3)
Chronic catarrhal cholecystitis ..	18 (4)	17 (5)	14 (3)
Chronic fibrous cholecystitis ..	2 (0)	3 (0)	0 (0)
Cholesterosis with stone ..	6 (0)	12 (0)	0 (0)

The surprising fact emerges that the proportion of diseased appendices is not lower but even rather higher among the unimproved cases than in those who derived benefit from the combined operation. Therefore it seems fair to conclude that the appendectomy had little to do with the outcome in most cases. If, however, those cases with a favourable result are excluded in which a definitely pathological appendix was removed, the figures in *Table VI* are obtained. These must represent the cases in which post-operative improvement was definitely due to removal of the gall-bladder. Since no exclusion was made from the 'unimproved' column, this system of evaluation must be regarded as stringently critical.

These carefully controlled observations should enable one to determine to what extent cholecystitis of the various types is specifically responsible for symptoms which are likely to be relieved by cholecystectomy—in other words, one should now be able to judge to what extent the various lesions are clinically significant. Actually the figures show that following cholecystectomy, either cure or

partial relief from symptoms resulted in 40 per cent of cases of simple cholesterosis, 52 per cent of those in which the gall-bladder showed a 'minimal lesion', and 60 per cent of those showing chronic catarrhal cholecystitis. The benefit in all of these cases may fairly be attributed to the cholecystectomy.

Table VI.—GALL-BLADDER PATHOLOGY AND PROGNOSIS AFTER DEDUCTION OF CASES IN WHICH BENEFIT MIGHT BE ATTRIBUTED TO APPENDECTOMY, LEAVING 125 STONELESS AND 18 STONE CASES—143 CASES IN ALL

	TOTAL	WELL	IMPROVED	UNIMPROVED	POST-OPERATIVE DEATH
Minimal lesion	50	9	17	21	3
Cholesterosis	27	9	1	16	1
Chronic catarrhal cholecystitis ..	44	14	12	14	4
Chronic fibrous cholecystitis ..	4	2	2	0	0
Cholesterosis with stone	18	6	12	0	0

The poor results in the cases of simple cholesterosis are particularly striking, and these are worse even than in the cases with a minimal lesion. The conclusion would seem justified that so far as the production of symptoms is concerned, cholesterosis of the gall-bladder is of no significance whatever. Since only half of the cases with 'minimal lesion' derived benefit from the cholecystectomy, it is clear that this type of cholecystitis is not invariably symptom-producing. The outlook is a little better in chronic catarrhal cholecystitis, but is still not entirely satisfactory. The results indicate that undue significance should not be attached to microscopic changes of this moderate degree. In the cases with more advanced gall-bladder disease—chronic fibrous cholecystitis, and cholesterosis with stone—the results were almost uniformly good, and were comparable with the large mass of statistics of many authors mentioned earlier in this paper.

It is clear that, just as cases with well-marked symptoms are likely to do better after cholecystectomy than those in whom the symptoms are vague, so removal of a definitely pathological gall-bladder is generally productive of a more gratifying clinical result than is excision of an organ in which the microscopic appearances are equivocal. It is desirable, without doubt, to operate before long-standing biliary disease has led to advanced secondary changes in other organs, but one will often suffer disappointment if one concludes, from mild or atypical symptoms and from doubtful pathological changes, that a case is one of early cholecystitis, suited for cholecystectomy. In any particular case, however, the responsibility of the gall-bladder for symptoms seems to be not quite proportionate to its deviation from histological normality. This is shown by the fact that a third of the cases of chronic catarrhal cholecystitis were unimproved, while a fifth of those with minimal lesions were actually relieved of all their complaints. These arguments assume that a train of symptoms originally arising from a lesion in the gall-bladder will be alleviated by its removal. This, of course, is not necessarily the case, and, on the other hand, it might well be that in some cases symptoms would actually be caused by the removal of the gall-bladder, especially if it had retained a proportion of its normal function.

The improvement in some of the cases where a minimally diseased gall-bladder was removed may have had nothing to do with the cholecystectomy, for

the symptoms may have arisen in a transient upset of some other part of the alimentary tract, and so have pursued a self-limiting course independent of the treatment exhibited. The majority, however, cannot be explained in this way. It must be remembered, in gall-bladder disease, that lesions of equal severity do not necessarily give rise to equally severe symptoms in different individuals. Something must depend upon the nervous sensitivity of the patient. Some women carry gall-stones to the grave with never an attack of colic; others have many colics, apparently without gall-stones. Possibly quite minor abnormalities in the valvular exit from the gall-bladder may dam back the fluid content and so give rise to colic, just as renal colic and hydronephrosis may result from the presence of a valve at the pelvi-ureteral junction. It is even possible that the disturbance of sensation known as biliary colic may have its origin occasionally in other sites than the gall-bladder. The same reservation may apply in even greater degree to the minor symptoms attributed to cholecystitis. These hypotheses would help to explain both the absence of histological changes in the gall-bladder in some cases with definite biliary symptoms and the occasional persistence of pain after cholecystectomy.

The Persistence of Pain after Cholecystectomy

The Germans have devoted much attention to the nervous origin of biliary pain, following the lead of Westphal (1923). Principally by experiments in which he used the Rehfuss duodenal tube, as in the method of Lyon and Meltzer for non-surgical biliary drainage, this investigator arrived at the conclusion that there are three motor elements in the biliary tract, the gall-bladder musculature, the sphincter at the gall-bladder neck, and the sphincter of Oddi at the lower end of the common duct. He suggested that any upset of the co-ordinated activity of these motor elements might give rise to pain, even when the gall-bladder showed no sign of organic disease. Westphal's ideas have not been generally accepted, and although his writings are attractive and his selected case records are impressive, there is a lack of complete statistical information. As a final criticism of this work, it may be mentioned that Halpert's microscopic preparations show conclusively that in many human subjects there is no definite sphincter of Oddi. More statistical anatomical work is needed upon the musculature of the biliary tract. It would be interesting to know whether cases without a sphincter of Oddi are less subject to biliary colic. Various other suggestions have been made from time to time to account for the persistence of distressing symptoms after cholecystectomy. Some authors lay the responsibility upon secondary changes in other organs. Hepatitis, cholangitis, pancreatitis, functional and organic disturbances of stomach, duodenum, or colon, and hypercholesterolæmia have all been indicted. The majority of the cases in this paper might fairly be regarded as examples of early and slight gall-bladder disease, and so secondary changes in other organs are less likely to have been present than, for example, in old-standing cholelithiasis. Since the present series is made up of stoneless cases it is unnecessary to take up the vexed question of relict stone, new-formed stone, or recrudescent symptoms without stone.

In general, the suggestion of Dr. Evarts Graham (1933), that, in the incompletely relieved cases, the gall-bladder was not originally responsible for all of the symptoms, is the most reasonable one.

The study of the correlation of pathological changes in the gall-bladder with the ultimate condition of the patient appears to justify certain definite conclusions regarding the value to the clinician of microscopic examination of the gall-bladder in cases of cholecystitis without stone. These conclusions are as follows :—

1. Histological changes in the gall-bladder are *not* an accurate index of the symptoms which have been produced by the latter. In any particular case, however, some assistance in assessing the responsibility of a stoneless gall-bladder for the symptoms may be obtained if the microscopic findings are evaluated in a general fashion, without attributing importance to slight deviations from the accepted normal histological picture.

2. Since this responsibility may not extend to all the complaints, relief following cholecystectomy may be only partial, but there is no way in which the pathologist can predict accurately the degree of improvement to be expected.

3. Undoubtedly, severe biliary symptoms may occasionally disappear after cholecystectomy despite the fact that the gall-bladder departs only slightly from normal, but certainly the more diseased the latter is, the more likely is the outcome to be happy. If cure be expected regularly whenever a minor lesion is found in the gall-bladder, disappointment will follow more often than not.

4. No support has been found for the view that the gall-bladder should be removed in the earliest stages (if such they be) of disease.

5. With regard to cholesterosis of the gall-bladder, no evidence has been obtained that this condition *per se* is liable to produce symptoms.

Cholecystography in the Present Series

The Relation between Variations in Cholecystographic Findings and Pathological Changes in the Gall-bladder.—The radiological test known as cholecystography rests upon the work of Graham and Cole (1924). From the two premises (1) that certain phthaleins are excreted in the bile, as shown by Rowntree and his co-workers, and (2) that the gall-bladder concentrates the bile, these investigators developed the argument that if the phthalein could be made radio-opaque by halogenation, then the gall-bladder might be visualized.

The physiological basis of cholecystography is the subject of dispute, but it is clear that, whatever the basis, cholecystography enables us to visualize a living process in which the mucous membrane of the gall-bladder is intimately concerned, and it will undoubtedly prove valuable if we can convert the information obtained into terms of pathological changes in the mucosa.

Table VII represents an analysis showing the various types of cholecystographic response encountered in the various categories of pathological lesions of the gall-bladder. It should be understood clearly that in those cases in which the cholecystogram is termed 'deformed' the density of the dye shadow was normal, but the outline of the gall-bladder was irregular, a state of affairs attributed to pericholecystic adhesions.

The figures and the terms are almost self-explanatory. The general result is that the great majority of the cases fall into the category "gall-bladder faintly visualized". The figures in the series of cases of simple cholesterosis do not differ markedly from those in cases histologically almost normal. This fact is further evidence against the existence of a definite inflammatory basis for lipoid infiltration of the gall-bladder. In the presence of marked lesions—namely, fibrous

cholecystitis or stones—no case concentrated the dye satisfactorily, and those of chronic catarrhal cholecystitis showed a tendency to cholecystographic impairment intermediate in degree. It is clear, therefore, that there is no type of cholecystographic reaction quite characteristic of any particular type of pathological change, although, as one would expect, the more advanced the pathology, the less is the chance of the dye being concentrated normally.

Table VII.—The Correlation of the Cholecystogram with Pathological Changes in the Gall-bladder, in 181 Stoneless Cases and 20 Cases of Cholesterosis with Biliary Calculi

Pathology	Total	Cholecystogram				Percentage in which Gall-bladder showed Normal Concentration of Dye (i.e., 'normal' and 'deformed')
		Normal	Deformed	Faint	No Shadow	
Minimal lesion	76	9	11	49	7	26
Cholesterosis	38	6	3	25	4	25
Chronic catarrhal cholecystitis ..	58	6	2	36	14	14
Chronic fibrous cholecystitis ..	9	0	0	3	6	0
Total of stoneless cases	181	21	16	113	31	20
Cholesterosis with stone ..	20	0	0	17	3	0

Provided that cholecystography is to be regarded as a test of the function of the gall-bladder, these results may be used further to support an attitude of scepticism regarding the importance of minor histological lesions, for if a gall-bladder which is so abnormal as to be classed as 'chronic catarrhal cholecystitis' may give on occasion a normal concentration of the dye, the significance of a few lymphocytes in cases classed as 'minimal lesion' must surely be debatable. Conversely, if we are to attribute significance to microscopic appearances, then the present findings fail to support statements made in the early period of cholecystography, that absence or faintness of the shadow invariably indicates a pathological gall-bladder.

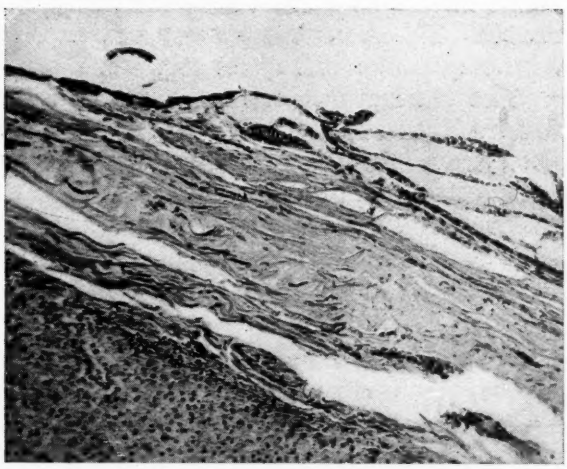

Fig. 187.—Unexpectedly normal histological findings in a case in which no shadow was obtained by cholecystography. The gall-bladder and liver both seem practically normal. The marked lysis of the lining epithelium is of course a post-operative phenomenon. (× 50.)

It is necessary to seek an explanation of the fact that in seven of the cases in which the gall-bladder lesion was minimal (*see*, for example, *Fig.* 187), no shadow was obtained by cholecystography, especially since the cholecystogram was an important element in the evidence leading to cholecystectomy.

From the time of its introduction, it has been emphasized that the Graham-Cole test demands an adequately functioning liver. In twenty-eight consecutive examples of enlarged liver due to various causes, Alexander and Bond, of St. Louis, were unable to visualize the gall-bladder (Moore, 1933). Moore states that, "Whether or not intensive disease of the gall-bladder is essential for the ablation of its concentrating function is not known, and on the other hand it is unknown whether loss of concentrating function is precedent or contributory to a chain of pathological changes which might eventuate in infection or stone formation". Again, "It is possible that disease of the appendix or other remote part of the alimentary canal might conceivably affect the gall-bladder to the point of destroying the concentrating function, as such lesions unquestionably affect alimentary secretions".

Another point that should be emphasized as a possible explanation of occasional non-visualization of relatively normal gall-bladders is the well-known fact that such failure of visualization may be quite temporary. Accordingly, unless the history points fairly definitely to gall-bladder disease, failure to obtain a shadow should not be accepted as conclusive evidence against the gall-bladder until the test has been repeated with confirmatory result. I am not aware that this is at all standard practice except in so far as a doubtful result after oral administration of the dye is sometimes checked by an intravenous test.

With regard to the 'faintly visualized' gall-bladders, it may be mentioned that Kirklin (1933) does not regard these as pathological provided the gall-bladder shadow is denser than that of the liver.

The conclusion to be drawn from this section of the study is that in cases of cholecystitis without stone, the cholecystogram corresponds only roughly with the histological findings in the gall-bladder, and occasionally the two sets of findings are difficult to reconcile. This does not imply that more importance should be attached to either one or other of the methods of investigation.

The Cholecystogram as an Index of Prognosis in the Stoneless Gall-bladder Treated by Cholecystectomy.—In many cases of the present series in which the clinical features were vague or atypical, the cholecystogram was an important factor in establishing the decision to remove the gall-bladder, and the correctness of these decisions may be checked by an analysis of the relation between the type of the cholecystographic response and the clinical result of cholecystectomy (*Table VIII*).

Table VIII.—The Relation between Cholecystogram and End-result after Cholecystectomy in 116 Cases, all Stoneless

Type of Cholecystographic Response	Total	Clinical Result				
		Well	Improved	Unimproved	Post-operative death	Percentage well or improved
Normal	10	5	1	4	0	60
Deformed shadow..	8	4	2	2	0	75
Faint shadow ..	76	22	23	28	3	59
No shadow.. ..	22	6	7	6	3	60
Totals ..	116	37	33	40	6	60

The figures show that cure or improvement followed operation in 60 per cent of all the cases. The smaller groups are really inadequate for detailed analysis, but it is seen that the probability of benefit from the operation was not greater in the cases in which no shadow was obtained than in those in which, according to this test, the gall-bladder was normal. This is a surprising and disappointing result, and its negative nature must be partially explicable as coincidence, due to the small number of 'normal cholecystogram' and 'no shadow' cases. The only group which stands out is that in which the shadow, though of satisfactory density, was deformed; of eight such cases, six were cured or partially relieved of their complaints as a result of operation. Deformity of the gall-bladder shadow is generally associated with dense pericholecystic adhesions, and the excellence of the results obtained in cases of this class, as compared with others in which pericholecystitis is less marked, has already been pointed out.

It is clear that much remains to be learned regarding the gall-bladder in health and disease. Cholecystography is a test of one of the functions of the gall-bladder, but the physiological factors which determine a normal reaction are not certainly established, and the factors which lead to a departure from the normal response are even less clear, and may well be manifold. Accordingly, while experience has proved that advanced disease of the gall-bladder will impair or prevent the development of the gall-bladder shadow, there is not yet reason to be sure that the converse is equally true. Diminution of intensity of the gall-bladder shadow need not necessarily imply that the organ is pathological, nor that it is responsible for the abdominal symptoms complained of by the patient, unless these are quite typically of biliary type. Much more work remains to be done before disease of the gall-bladder can be recognized cholecystographically with precision.

Impairment of the density of the cholecystographic shadow is not of itself evidence that removal of the gall-bladder will be followed by a satisfactory clinical result.

GENERAL CONCLUSION

From a detailed study of 243 cases of cholecystitis without stone and 21 cases of cholesterosis of the gall-bladder accompanied by gall-stones, the following conclusions have been reached:—

In cases of cholecystitis without stone, cholecystectomy carries a mortality of 3 per cent. Cure of symptoms results in 30 per cent, and improvement in 30 per cent. In 37 per cent the end-result of operation is unsatisfactory.

Cholecystitis without stone seems to belong to a region on the borderline between functional and organic disease.

No single test is infallible, though in the individual case study of the clinical history, of the cholecystogram, and subsequently of the microscopic sections may each yield information pointing toward or away from the gall-bladder.

The results of cholecystectomy indicate that it is dangerous to over-emphasize any one of these methods of investigation, or to attribute importance to minutiæ.

To establish a diagnosis of cholecystitis the history must be typical, and should include pain. No evidence has been obtained that either flatulent dyspepsia or 'food selection' necessarily indicates gall-bladder disease or is likely to be relieved by removal of the gall-bladder.

Cholecystographic changes must be definite; and mere impairment of the

density of the gall-bladder shadow does not invariably mean that the gall-bladder is pathological. While, as is well known, almost every gall-stone will be revealed by the use of the dye test, the same degree of precision is not attained in the field of stoneless cholecystitis.

Microscopic changes are probably not significant unless they are fairly gross. The rather surprising conclusion has been reached that cholesterosis of the gall-bladder is not of itself a pathological or symptom-producing condition.

A considerable proportion of patients are unrelieved by removal of a stoneless gall-bladder; the therapeutic failures are due to symptoms having their origin outwith the gall-bladder. The appendix, however, does not seem frequently to be the organ responsible.

The results of surgical treatment of cholecystitis without stone are relatively unpredictable in the individual case, even by the most modern of laboratory procedures. Certainly they are not so good as in the presence of gross organic disease, when, generally speaking, symptoms are clamant and relief after operation is dramatic.

This work was done during 1932–3, while the author held a Rockefeller Foundation Travelling Fellowship in Surgery, and in the first place the warmest thanks are due to the Rockefeller Foundation for Medical Research. Material for the study was obtained at Washington University Medical School, St. Louis, Mo., and the investigation was facilitated by the wholehearted co-operation of the staff of Barnes Hospital. Records were made available without restriction, and help given in the tracing of cases. Dr. Evarts A. Graham gave in addition much time and interest to the planning of the investigation and to its direction while in train. Dr. Sherwood Moore, of the Edward Mallincrodt Institute of Radiology, was generous of his time in the discussion of radiological interpretation. Miss Gertrude Cassell, of the Department of Surgical Pathology, prepared numerous excellent histological specimens. Miss Dorothy Blanchard and Miss Ada Hanvey gave unstinted assistance in the tedious secretarial work involved in the follow-up study, and Miss Agnes Kelly, of Glasgow, in the final compilation.

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PANCREATIC FISTULA

REPORT OF A CASE: CURE BY PANCREATO-GASTROSTOMY*

By ROBERT M. JANES, Toronto

Pancreatic fistulæ result from injuries to the pancreas, from the treatment of cysts of the pancreas by marsupialization, or from extensive necrosis of the gland. Few of these fistulæ persist. Of thirty-three pancreatic cysts treated by marsupialization by Judd, Mattson, and Mahorner,[1] none required further treatment. In some the discharge continued for a few weeks only, in others for a few months, and in a few for a year. The maximum period of discharge was two years. Injuries are likely to produce a niche in the gland where it is squeezed against the anterior surface of the vertebra, and not an injury to the main duct. It seems probable that, as suggested by Kahn and Klein,[13] spontaneous closure is likely to occur unless the continuity of the duct of Santorini is interrupted, in which case the secretion from the portion of the pancreas distal to the point of injury can escape only by way of the fistula.

Only in those cases in which the communication with the pancreas is so located that the greater portion of the secretion escapes by way of the fistula is digestion likely to be seriously interfered with. In the case to be reported not more than one-fourth of the gland retained its connection with the intestine, yet at no time was there evidence of failure of pancreatic digestion. It has been shown experimentally that loss of the total supply of pancreatic juice is rapidly fatal.[11, 12] When the loss of secretion is great the collected discharge should be fed to the patient. When practically moribund, experimental animals may be restored to an apparently normal state by the giving of whole pancreatic juice by the mouth.[11] Cathala and Sénèque[3] demonstrated an equally beneficial effect in man. The lives of animals in which complete fistulæ have been established can be prolonged greatly by the administration of large quantities of normal saline. In the present case the administration of normal saline seemed sufficient to maintain the general health owing presumably to the fact that enough secretion continued to be discharged into the intestine.

Since pancreatic juice may be activated by contact with any tissue, a rapid digestion of the abdominal wall is likely. This may be controlled by the removal of the secretions from the fistula by way of a catheter to which a suction pump is attached, or by inactivation of the secretion as suggested by Potter,[6, 7] through the continuous addition to it of sufficient N/10 HCl to render its reaction acid and the use of a dressing of 10 per cent Witte's peptone to take up any enzymes not rendered innocuous in the acid medium. Removal of the secretion by suction proved entirely satisfactory in this case. As much as 20 oz. was collected daily; all three enzymes

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* From the Department of Surgery, University of Toronto and the Toronto General Hospital. Read before the Academy of Medicine, Toronto, Oct. 17, 1933.

were present and active. The skin about the mouth of the fistula was protected by a paste of bismuth in olive oil.

Since spontaneous closure of a pancreatic fistula may occur up to one year and even occasionally two years, it would seem that at least the former period should be allowed to elapse before any radical surgical measures are undertaken. Serious impairment of health as a result of the loss of pancreatic juice, and the certainty that the fistula constitutes the only possible escape for secretion from the portion of gland distal to it, would appear to be exceptions to this rule.

Two possible methods of surgical attack suggest themselves: first, excision of the fistula along with the portion of pancreas discharging into it, and, second, implantation of the mouth of the fistula into an adjacent hollow viscus. The former is much too dangerous and has been rejected in favour of the implantation, which is comparatively safe. Implantation into the stomach, gall-bladder, duodenum, and jejunum has been done, but so far as one can discover it has been done successfully only into the stomach. Implantation into the stomach would appear to be preferable because of the ease with which it may be carried out and because the secretion when emptied into an acid medium is at once inactivated. There does not seem to be any convincing evidence that radium treatment is of value. Corachan,[4] writing in 1928, was able to collect six cases in which implantation into the stomach had been done successfully, one each by Doyen (1905), Michon (1911), Jedlik (1921), Gutierrez (1925), Courboulis (1926), and his own in 1927. Cathala and Seneque[3] reported a seventh successful case in 1930. The following appears to be the eighth successful case to be reported.

HISTORY.—Mrs. E. M., aged 54 years, was admitted to the hospital on May 20, 1932. Four years previously she had had an attack of severe upper abdominal pain which confined her to bed for three weeks. The stools were light-coloured and the urine dark, but she had not been jaundiced. During the following years she had remained well apart from some indigestion. Two weeks before admission she was wakened at night with terrific pain in the epigastrium; frequent vomiting occurred. A physician was called who administered hypodermics. During the next three days a continuous pain remained, with periods of increased severity. The physician called twice daily to relieve the pain by hypodermics. She continued to vomit dark brown material. During the following ten days the pain persisted but was less severe; she developed a fever.

ON ADMISSION.—When admitted to hospital the patient was fairly comfortable. The temperature was 103°, the pulse 100, blood-pressure 104/62, and the white blood-cells 21,000. The specific gravity of the urine was 1013, it was acid, and contained no albumin and no sugar.

ON EXAMINATION.—The abdomen was moderately rounded. There was some general rigidity of the upper abdomen with tenderness in the right hypochondrium, where an indefinite mass which was regarded as a distended gall-bladder could be felt. A diagnosis of cholecystitis and cholelithiasis with possible pancreatitis was made. During the following week there appeared to be some improvement.

On May 29 at 7 p.m. she experienced severe epigastric pain and vomited about four ounces of coffee-ground material. Examination at this time revealed a rounded, rather sharply delimited mass about the size of a grape-fruit which filled

the whole epigastrium. The vomiting of coffee-ground material continued, and by 8 p.m. the blood-pressure was 80/35 and a little later 70/35; the pulse-rate increased to 150 per minute. Her condition slowly improved, and when seen by me at 5 p.m. the following day it was not alarming. The previously described mass was easily palpated and its position between the liver and stomach, pushing the latter downward and to the left, was confirmed by a small barium meal (*Fig.* 188). The diagnosis of acute pancreatic necrosis with hæmorrhage seemed obvious.

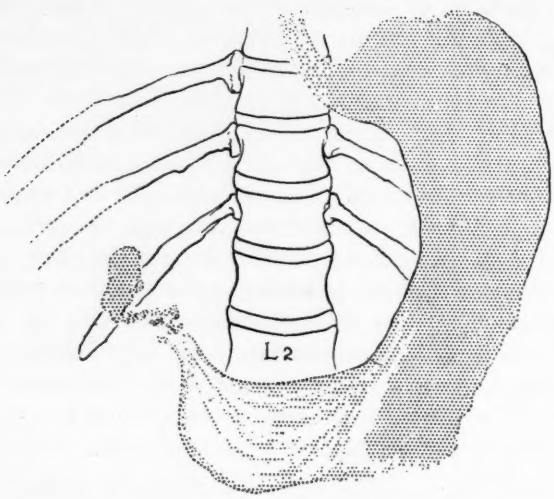

FIG. 188.—Stomach displaced downward and to the left by mass rising above the lesser curvature, and filling defect in the stomach produced by the enlarged pancreas.

FIRST OPERATION.—The abdomen was opened at 8 p.m. under spinal anæsthesia. There was extensive fat necrosis; a mass the size of a grape-fruit bulged forward from behind the lesser omentum. The head and tail of the pancreas were both greatly enlarged and stony hard. The gall-bladder contained three rather large stones; the cystic duct contained no stone; the common duct was small and contained no stone. The lesser omentum and posterior peritoneum were incised and about 10 oz. of blood-clot were evacuated, then a greyish mass of pancreas 4 by $1\frac{3}{4}$ by 1 in. It was now evident that the middle third of the pancreas had been removed as a slough. A $\frac{3}{4}$-in. tube containing a gauze wick was introduced into the lesser sac, the gall-bladder emptied and drained, and the abdomen closed.

The following day the patient was remarkably well. There was a free discharge of bile from the gall-bladder, and opalescent fluid in large quantities, at first blood-stained, escaped from the lesser sac. On June 4, because the skin of the abdomen was becoming excoriated, a suction pump was attached.

Drainage from the pancreatic fistula reached a maximum of 20 oz. daily. It contained no bile until the gall-bladder drain was removed on June 22, following which the discharge was bile-stained. The fluid collected gradually decreased in amount up to July 22, at which time all tubes were removed and the suction was discontinued. The patient was allowed home on Aug. 11. A fistula the size of a 10 F catheter persisted from which a little limpid fluid escaped.

RE-ADMISSION.—On Sept. 11 she was re-admitted with the history that on three occasions since discharge the drainage had ceased and she had coincidently developed pain in the epigastrium and vomiting; relief was obtained by re-opening the fistula. During the next two months this occurrence was repeated many times. By Dec. 12 a mass the size of an orange had formed in the epigastrium. She was allowed home again. On Jan. 16, 1933, she was re-admitted with a history of having been fairly well since last seen. The fistula had closed, but the mass in the epigastrium was now two-thirds the size of an association football (*Fig.* 189). A little bile-stained mucus was escaping from the gall-bladder.

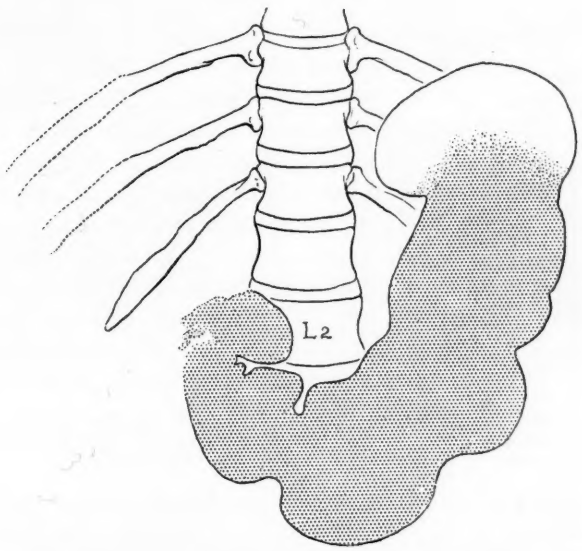

FIG. 189.—Displacement of stomach produced by pancreatic cyst.

SECOND OPERATION.—On Jan. 27, under spinal anæsthesia, the pancreatic cyst was exposed, opened, and 1200 c.c. of slightly yellowish fluid were evacuated from it. The cyst wall was thin and bluish in colour. Two ounces of pure formalin were introduced and allowed to remain in contact with the lining of the cyst for five minutes. The cyst was marsupialized.

During the next few weeks there was a discharge of grumous material with sloughs of cyst lining. The fluid became increasingly clear, and by March 16 12 oz. of clear fluid were being discharged daily, which, despite the fact that it was active in pancreatic ferments, showed no tendency to digest the skin. This was due, presumably, to the fact that it was escaping along a dense fibrous channel which did not activate the enzymes. On April 12 lipiodol was injected into the fistula and a clear outline of the tail of the pancreas obtained (*Fig.* 190). There was transient abdominal pain following this.

THIRD OPERATION.—On April 18 the patient was again operated upon under spinal anæsthesia. It proved easy to dissect the fibrous fistulous tract as far as its origin from the pancreas. It was implanted into an adjacent area on the posterior wall of the stomach. In order to rid the patient of a small biliary fistula

the gall-bladder was removed. A $\frac{1}{4}$-in. rubber drainage tube was placed above the stomach to the site of implantation and the abdomen closed.

The post-operative course was uneventful. The drain was removed at the end of forty-eight hours and the wound healed by primary union. The patient was discharged from hospital at the end of three weeks and has remained well. She has no indigestion and no abdominal discomfort. Barium examination of the stomach now demonstrates no deformity or other evidence of the presence of the pancreato-gastrostomy (*Fig.* 191).

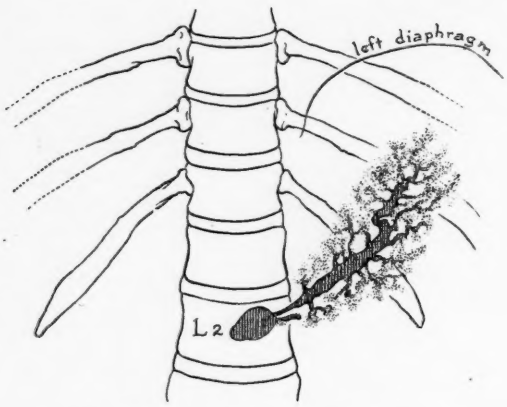

FIG. 190.—Outline of pancreas obtained by injecting lipiodol into the fistula.

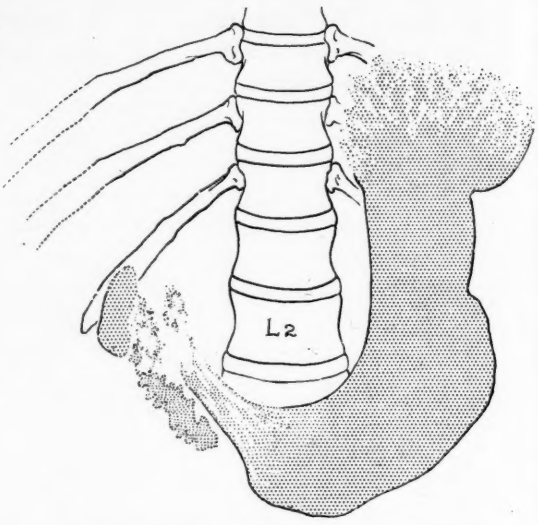

FIG. 191.—Barium meal demonstrates no deformity of the stomach or other evidence of the presence of the pancreato-gastrostomy.

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TORSION OF THE GALL-BLADDER

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ALTHOUGH torsion of the gall-bladder is reputed to be a rare condition, it ought not to be left out of mind by the surgeon. We have had three cases under our care within the past four years, so it seems probable, as with other so-called ' rare ' conditions, that a good many cases go unreported. Four surgeons have reported two each, and one (Henschen, of St. Gall) has seen three.

We believe that it should often be possible to make a diagnosis before operation, and if this is done it will probably open the way to save the patient's life by timely surgery.

Although nine cases have been described by British surgeons in addition to our own, there does not appear to be any detailed account of this disease in English literature, and widely read text-books of surgery which we have consulted make little or no reference to it.

HISTORY

The first case on record was published by A. V. Wendel in America in 1898, and is, with one exception, the youngest patient reported; also it is the only one in which the gall-bladder perforated. Ten years later, three cases were described from Germany. The best descriptions of acute torsion of the gall-bladder are those of A. M. Shipley (American), P. Costantini (Italian), and P. Brocq (French). A table of the recorded cases is given on pp. 302–4.

Cases have also been described by the following observers, but we have not been able to consult the accounts, as the literature was not accessible to us :—

Henschen, 1915 (three cases)
Daux, 1924 (girl of 11)
Lutaud, 1924
Ceccarelli, 1926 (two cases)
Daraignez, 1926
Ramshorst, 1926
Romani, 1928 (this patient had appendicitis as well)
Meeker and Liserby, 1932

In 1925 A. Fischer, of Budapest, described two cases of recurrent and incomplete torsion of the gall-bladder, both in women, aged 44 and 29 respectively. Both complained of repeated attacks of pain in the right hypochondrium, without jaundice, and both suffered from general visceroptosis. They were operated on in a quiescent interval and did well. In both cases stones were present, and the torsion was through 90°. In one case the gall-bladder was removed, and in the other it was anchored by sutures. Fischer quotes another case reported by Seefisch, who also operated and anchored the gall-bladder by suturing.

ACUTE CASES OF TORSION OF THE GALL-BLADDER

AUTHOR	YEAR AND PLACE	AGE	SEX	DESCRIPTION	STONES	TREATMENT	RESULT
Wendel, A. V. ..	1898	23	F	Lump found in November, 1895. Attack of pain in 1896. Operation in 1897	213	G.B. twisted and perforated. G.B. removed	Recovered
Mayer, W. ..	1908, Mannheim	54	F	5th day. Acute pain. Tumour. Pulse 150. Diagnosis: intestinal obstruction, due to hydronephrosis	Yes	G.B. removed	Died
Muhsam, R. ..	1908, Berlin	61	F	Pulse 96, temp. 99°. Tumour felt under ether, not before. Diagnosis: appendicitis	No	G.B. removed	Recovered
Nehrkorn ..	1908	74	F	Long history. Operation on 8th day. Diagnosis: empyema of gall-bladder	No	G.B. removed	Recovered
Lett, H.	1909, London	72	F	3rd day. Temp. 101°, pulse 100. Tumour felt. Diagnosis: cholecystitis	Yes	Mesentery present. G.B. removed	Died
Fischer, A. ..	1910, Darmstadt	70	F	3rd day. Tumour felt. Diagnosis: cholecystitis or appendicitis	No	G.B. removed	?
Kubig, G. ..	1912	73	M	Died of phthisis	No	P.M. case	
Cramp, W. C. ..	1915, New York	?	M	Temp. 99°. Rigidity and pain. No lump	No	G.B. removed	Recovered
Reichel	1919, Chemnitz	71	F	3rd day. Pulse 88. Pain, vomiting. No lump. Diagnosis: appendix	No	Twist clock-wise. G.B. removed	Recovered
Krabbel, Max ..	1920	73	F	4th day. Temp. 98°. Tumour. Diagnosis: intestinal obstruction from cancer of colon	One	G.B. removed	Recovered
		64	F	Previous attacks of gall-stone colic: 24 hours' history. Distended. Tumour. Pain and vomiting. Diagnosed correctly before operation		G.B. removed	Recovered
Strauss, M. ..	1921	42	F	Pain, vomiting, constipation. Tumour. Temp. 98°, pulse 108. Diagnosis: cholecystitis + hydrops	One	G.B. removed	Recovered
Hansen, P. N. ..	1921	79	F	24 hours. Tumour, pain, vomiting. Temp. 98°, pulse 70. Diagnosis: ileus	No	360° clockwise. Hour-glass, only distal portion twisted	Recovered
Feldmann	1922, Berne	46	F	1st day. Temp. and pulse normal. Pain; no tumour	Yes	Twisted 180°. G.B. removed	Recovered
Frankau, C. H. S.	1923,	63	F	24 hours. Temp. 97·6°, pulse 112	No	Mesentery. G.B. removed	Recovered

Berne				Pain; no tumour		removed	
Frankau, C. H. S.	1922, London	62	F	24 hours. Temp. 97·6°, pulse 112. Pain. Tender. No tumour. Vomiting, constipation	No	Mesentery. G.B. removed	Recovered
Irwin, S. T. ..	1922, Belfast	34	F	26 hours. Temp. 99°, pulse 90. Pain and vomiting. Tender and rigid. No tumour	No	G.B. removed	Recovered
Jonas, H. C. ..	1923, Barnstaple	67	F	24 hours. Pain, vomiting. Tumour. Diagnosis: cancer of colon and intestinal obstruction	Yes	G.B. removed, very easy	Recovered
Dubs, J.	1924	Aged	F	Tumour, pain	?	Mesentery. G.B. removed	Recovered
Fifield, L. R. ..	1925, London	54	F	48 hours. Pain, vomiting. Lump felt. Temp. 99°, pulse 94	No	Mesentery. G.B. removed	Recovered
Huddy, G. P. B.	1926, Birmingham	71	F	Previous attacks. Ill several days with pain. Temp. normal, pulse 108. Lump appeared after a few days. Diagnosis: appendix abscess	No	Anti-clockwise. G.B. removed. Easy	Recovered
Grunert, A. ..	1926, Berlin	66	F	Gall-stone colic for years. 3rd day, severe pain. Tumour. Temp. normal. Diagnosis: acute cholecystitis	Stone in G.B. and C.D.	Torsion 180°. Stones in G.B. and C.D. removed. G.B. removed	Recovered
		67	F	2 days' pain. Temp. normal, pulse 110. Tumour	One	360° torsion. Gangrenous. Mesentery. G.B. removed	Died
Sutter, A. ..	1925	74	F	Previous attacks. Sudden pain, vomiting. Tumour six days later	?	Anti-clockwise. G.B. removed	Ducts tied. Died jaundiced
Marinacci, S. ..	1926	—	F	Tumour. Diagnosis: twisted ovarian	?	G.B. removed	Recovered
Holden, W. B. ..	1927, Portland, Oregon	49	M	24 hours. Distension, pain; rigid and tender. Diagnosis: perforated gastric ulcer or cholecystitis	No	G.B. removed	?
Zum Busch, J. P.	1927, Liestal	75	F	8 days. Pain. Tumour which came and went	No	Mesentery. G.B. removed	Recovered
Shipley, A. M. ..	1927, Baltimore	65	F	Pain began ten days before. Again two days ago. Rigid. Temp. 100°, pulse 100. Diagnosis: G.B. or appendix	No	Mesentery. G.B. removed	Recovered
Esau	1927	48	F	Repeated attacks of colic. Tumour felt for weeks. 2nd day. Diagnosis: gall-stones	Yes	G.B. removed	Recovered
Meade, H. ..	1929, Dublin	36	F	Pain, which stopped; nil found. Recurred twice. Temp. 99°, pulse 100. Rigid. Operation next day	No	Mesentery. G.B. removed	Recovered

Continued on next page

ACUTE CASES OF TORSION OF THE GALL-BLADDER—*continued*

AUTHOR	YEAR AND PLACE	AGE	SEX	DESCRIPTION	STONES	TREATMENT	RESULT
Gwyne, R. G. ..	1930, Redhill	77	F	Pain, vomiting, tumour. Pulse 80, temp. 98°	One	Clockwise. Mesentery. G.B. removed	Recovered
Costantini ..	1930, Gallarate, Lombardy	42	M	3rd day. Pain, vomiting. No tumour. Diagnosis: intestinal obstruction	No	Mesentery. G.B. removed	Recovered
Kettner	1930, Karlsbad	55	F	Tumour felt. Temp. normal. Diagnosis: volvulus of G.B.	?	Twisted 180°. G.B. removed	?
Brocq, P.	1931	70	F	Pain, vomiting, tumour felt. Temp. normal after 36 hours. Diagnosis: G.B. Pulse and temp. rising. Tumour no longer felt	No	G.B. brought out, tube tied in	Recovered
Kowalenski ..	1931, Voronesch	67	F	10 days' pain. Pulse 90, temp. normal. Tumour. Diagnosis: appendicitis	No	Thrice twisted. Mesentery. G.B. removed	Recovered
Rouhier	1931	78	F	Diagnosis: intestinal obstruction ..	?	Anti-clockwise. G.B. removed	Recovered
Leriche	1931	—	—	Diagnosis: acute cholecystitis ..	?	Bilocular. Fundus twisted. G.B. removed	Recovered
Herfarth, H. ..	1932, Glogau	46	F	Pain 6 weeks. Temp. normal. Pain, tenderness; no tumour	No	Distal part of G.B. twisted. G.B. removed	Recovered
Murray, J. F. ..	1932, Dundee	83	M	3rd day. Pain, vomiting, rigidity, tenderness; no tumour	No	Clockwise. G.B. removed; easy	Died 6 weeks later
Rendle Short ..	1929, Bristol	69	M	4th day. Pain, rigidity, tenderness. No tumour felt till under anæsthetic. Diagnosis: perforated gastric ulcer	No	Anti-clockwise. G.B. removed	Recovered
	1933, Bristol	81	F	Pain, vomiting. 1st day. Temp. and pulse normal. Tumour which came and went. Diagnosis: acute G.B.	One	G.B. removed	Recovered
Paul, R. G. ..	1933, Bristol	82	F	Pain, vomiting. 1st day. Temp. 100°, pulse 120. No tumour. Rigid, tender. Diagnosis: appendicitis	One	180° anti-clockwise. G.B. removed	Recovered

In addition to the above, two cases were described by H. Krukenberg in 1903, in which kinking of the gall-bladder gave rise to attacks of colic; it was found to be long and acutely flexed on itself. It was fixed in better position, and both patients, young women, were cured. We have not reckoned these as torsion cases.

CASE REPORTS

Case 1 (A. R. S.).—Mr. W., aged 69, seen at the Bristol Royal Infirmary on June 17, 1929, complaining of pains in the chest. Four days previously the patient got up to go to work and had a pain, but managed to carry on. The next day he went to Dr. Morgan, who sent him up to the Out-patient Department, and he was admitted. Pains were continuous, lasting through the night, and prevented him sleeping. No vomiting. The upper abdomen was rigid and tender. Pulse and temperature were normal. The clinical diagnosis was carcinoma of the stomach, or leaking gastric ulcer. Palpation of the abdomen under an anæsthetic revealed a lump in the liver region, which was thought to be a secondary growth

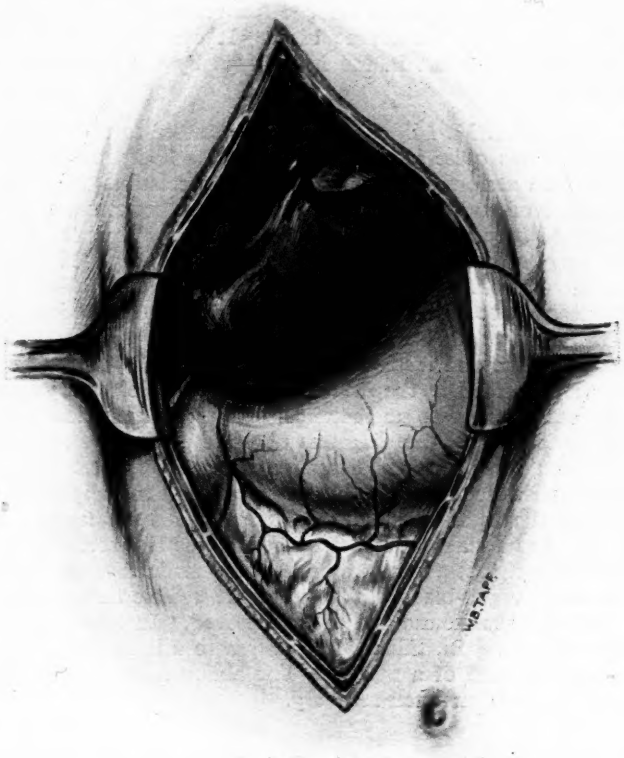

FIG. 192.—*Case* 1. The condition of the gall-bladder found at operation.

in the liver. A small incision was made, and as it did not feel like a growth, the incision was prolonged, and revealed a large black lump attached to the liver which was found to be the gall-bladder. It was twisted on its pedicle, and was removed quite easily. Further exploration of the abdomen revealed a right hydronephrosis due to stone, which was left alone, as the patient was not in a good condition. The abdomen was closed through and through with silkworm gut. The gall-bladder was black, the wall greatly thickened, but not quite gangrenous. There were no stones. The rotation was anti-clockwise. The patient has been very well since (March, 1934). The condition is shown in *Fig.* 192.

Case 2 (A. R. S.).—Mrs. M., aged 81, seen in consultation with Dr. Fells on Oct. 12, 1933. The patient had had jaundice some weeks previously, followed by pain. She was seized at 9 a.m. on the day of examination with violent colicky pain in the centre of the abdomen, some diarrhœa, and persistent vomiting. Pulse and temperature were not affected. The face was sallow, but there was no true jaundice. On examination of the abdomen a swelling about 4 in. long, having the general characters of an enlarged gall-bladder, was felt projecting below the ribs in the right hypochondrium downwards and slightly inwards. It was freely movable. The abdomen was not distended. There was slight rigidity and tenderness over the tumour. Rectal examination was negative. A tentative diagnosis was made of probable empyema of the gall-bladder, or possibly intussusception, and an immediate operation was advised.

By the time the patient had been removed to a nursing home the pain had gone, and the swelling had practically disappeared. She wanted to be let off the operation, but we advised her that it would be better to go on with it. Under the anæsthetic *no tumour could be felt*, and once again the question arose of abandoning the operation, but fortunately it was decided to open the abdomen. We then found a large gall-bladder, dusky red in colour, and the wall much thickened. It was twisted on its pedicle, but had probably partly untwisted. The swelling was soft in consistency. There was a little free fluid in the abdomen. The gall-bladder was removed with surprising ease. After removal, it was opened; the wall was half an inch thick, the mucous membrane black. It contained one stone, the size of a pigeon's egg. The patient was not in the least upset by the operation and made a very quick and easy recovery.

Case 3 (R. G. P.).—Mrs. M. M., aged 82, was admitted to the Bristol Royal Infirmary on March 25, 1933. It was quite impossible to obtain a lucid history from the patient as she was rather senile and almost completely deaf. The relatives, however, stated that the woman had complained of sudden severe epigastric pain that morning, accompanied by vomiting. The pain had been practically continuous, and the vomiting had recurred several times. There had been no movement of the bowels that day. No previous history of abdominal trouble was elicited.

The temperature was 100°, pulse 120 and irregular on admission. The patient was markedly shocked and the general condition bad. The abdomen was somewhat distended, and the right hypochondrium and iliac fossa rigid. Tenderness, which was present all over the right side, was most marked in the iliac fossa. No swelling was palpable owing to the muscular resistance, and there was no jaundice. Rectal examination was negative.

In spite of the patient's age, the diagnosis of acute perforative appendicitis was made, and the abdomen opened through a small incision in the iliac fossa. On incising the peritoneum a quantity of dark blood-stained fluid escaped, and the appendix was found to be normal. On exploring the right side of the abdomen with the fingers, a swollen tightly distended gall-bladder was found, which further examination revealed to be gangrenous. Rather than extend the incision, a second opening was made through the rectus below the right costal margin, and the gall-bladder, twisted on its pedicle through an angle of 180° in an anti-clockwise direction, was found and easily removed. In colour it was a deep purple-black, with an engorged wall $\frac{3}{8}$ in. thick. In addition to a little fluid, it contained a single cholesterol stone about the size of a marble. The abdomen was closed in the usual way, and the patient made an uninterrupted recovery.

MECHANISM OF TORSION

In many recorded cases of torsion of the gall-bladder, the surgeon noted the presence of a mesentery. According to Brewer this is to be found in the anatomy department in 5 cases out of 100, and Ssulow confirms by reporting it 6 times in 145 cases. Our surgical experience would lead us to the opinion that it is nothing like so frequent as this, and text-books of anatomy, such as Poirier and Charpy, state that it is rare. Jacquement, quoted by Shipley, found it twice in 200 cases. It is probably a matter of nomenclature; obviously a part of the gall-bladder would be united to the liver by the mesentery far more often than the whole gall-bladder.

In our opinion a more important factor than a mesentery is a short attachment. In our cases the cystic duct and the neck alone appeared to be attached to the liver, and the body and fundus were free. Probably in aged females the attachments have become loosened.

In three patients (Hansen's, Herfarth's, and Leriche's) the gall-bladder was hour-glass in shape, and only the distal portion was twisted.

The cause of the torsion is probably related to the movement of normal peristalsis in the transverse colon. As this sweeps across the colon three or four times a day from right to left it seems a probable suggestion that the lower surface of the gall-bladder might be carried along in an anti-clockwise direction, and it is interesting in this connection to observe that when the nature of the twist has been recorded, it has been anti-clockwise much more frequently than in the opposite direction.

One might have expected that stones in the gall-bladder would have been a predisposing factor by giving more purchase to the colon in producing a twist, but as a matter of fact stones are recorded as present in 15 cases and absent in 21 others. It is well known that in elderly women stones are frequently found, and the ratio is not much higher in the torsion cases, so this factor is evidently not important.

SIGNS AND SYMPTOMS

The great majority of patients have been elderly females, but a certain number have occurred in younger women: for instance, Daux's case was only 11, and Wendel's 23. There were 16 cases over seventy years of age. There have been only 6 cases in males, one of which was under our care. Previous history may show evidence of gall-bladder trouble. There may have been attacks of pain, and in one or two cases jaundice. On the other hand, many cases have enjoyed unbroken good health.

Signs and symptoms are fairly constant. The patient is seized rather suddenly with colicky pain in the centre of the abdomen or in the right hypochondrium which persists until operation is performed, although there may be remissions. Vomiting is usually present and sometimes urgent. Bowels may be constipated, normal, or there may even be a little diarrhœa. Jaundice is absent. For the first day or two pulse and temperature are normal, or only slightly raised (temperature 99°, pulse 90), but after two or three days both show marked rise. In most of the cases a definite rounded tumour, having the general characters of an enlarged gall-bladder, has been felt. It has often been recorded that the tumour is mobile. In some cases it is obscured, the tumour only being felt when the patient has been under an anæsthetic, or not at all. There is a certain amount of tenderness and rigidity over the gall-bladder. As our second case shows, the tumour varies in hardness; it may be very easily felt on one examination and almost entirely gone a few hours later, owing, in all probability, to partial untwisting. This sign could scarcely occur in any other condition, except hydronephrosis, and perhaps intussusception.

After two or three days the condition of the patient deteriorates, and the gall-bladder has often been found gangrenous, though general peritonitis has supervened only in a few. The pulse and temperature rise, and delayed operation has usually failed to avert a fatality.

DIAGNOSIS

We believe that in those cases, the majority, in which a tumour having the general characters of an enlarged gall-bladder can be felt, a diagnosis can and should be made before operation, to the patient's very great advantage. The acute pain and vomiting, without jaundice, in an elderly female, and the appearance, *within a few hours of the onset*, of the greatly enlarged and palpable gall-bladder, are highly suggestive. If, as in one of our cases, and a few others (Brocq, Zum Busch), *the tumour comes and goes*, it can scarcely be anything else. Krabbel made a correct pre-operative diagnosis in his second case. We regret that we did not do so in ours. Kettner also correctly diagnosed his case before operation. The usual pre-operative diagnoses have been: cholecystitis, hydrops or empyema of the gall-bladder (11 cases), intestinal obstruction (5 cases), appendicitis (7 cases), cancer of the colon or stomach (2 cases), perforated gastric ulcer (2 cases), twisted ovarian cyst (1 case), hydronephrosis (1 case).

TREATMENT

It is important not to delay operation in these cases on the supposition that it is a cholecystitis which will clear up. As the table shows, patients operated on after forty-eight hours often died, whilst all those treated early recovered. Surgeon after surgeon comments on the surprising ease with which the gall-bladder has been removed, the parts being so freely mobile. For this reason cholecystectomy is likely to lead to recovery even in patients of great age. Several, including two of ours, did very well though over eighty. In one case, Sutter's, the mobility of the parts led to the surgeon's undoing, for the ligature included the hepatic and common bile-ducts, and the patient died of obstructive jaundice.

Of the 39 cases operated on in which the result is stated, 34 lived and 5 died (operation on the third day in three, fifth and sixth one each). No doubt the true mortality is higher; fatal cases are apt to go unreported.

SUMMARY

1. Three cases of acute torsion of the gall-bladder are described, and a brief report is given of fifty others from the literature.

2. A pre-operative diagnosis could often be made, the grounds being the occurrence of acute pain and vomiting, especially in an elderly female, with a palpable tumour having the general characteristics of an enlarged gall-bladder, which comes up within a few hours, and may appear and disappear. In some cases, however, the swelling is masked by rigidity and tenderness.

3. Early cholecystectomy usually saves the patient, even in octogenarians. The operation is a very easy one in these cases.

4. Cases of recurrent partial torsion are on record, but are less frequently seen.

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ONE-STAGE LOBECTOMY FOR BRONCHIECTASIS* AN ACCOUNT OF FORTY-EIGHT CASES

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ALL writers on pulmonary disease are agreed that bronchiectasis is a pathological condition of which the progress is only delayed by intermittent palliative measures. As is stated by Powell and Hartley, "Bronchiectasis, owing to its anatomical characters, is not a disease from which we may expect recovery. At the best, all that we may hope for is that by preventing decomposition of the sputum, we may be able to arrest its further progress. In nearly all cases, in spite of treatment, the disease gradually advances, although its duration varies much in different individuals, in some cases being exceedingly chronic, in others running a comparatively acute course." It is for this reason that attempts have been made by operative measures to arrest or to eradicate the disease. Necessarily, operations upon individuals who have been for some considerable period subjected to the results of chronic infective processes assume a severity which would not be so marked a feature in a relatively healthy individual.

PATHOLOGY AND SYMPTOMATOLOGY OF BRONCHIECTASIS

It is not our intention here to discuss otherwise than very broadly the etiology and pathology of bronchiectasis, for its causation is still a matter of some doubt and the rate of its progress varies considerably in different individuals. Unquestionably there is a condition of primary bronchiectasis—i.e., a dilatation of the bronchi unassociated with infection or any other gross pathological lesion in the lung. This has been described as congenital, and arises primarily in the lower lobe, more particularly in that of the left side. Whether this type invariably becomes secondarily infected and gives rise to symptoms is debatable, but that a certain proportion of these cases do so is unquestionable.

Secondary bronchiectasis may arise as a sequel to infective processes, such as bronchitis, lung abscess, tuberculosis, etc., and to conditions causing intermittent or more permanent obstruction of a greater or lesser portion of the bronchial tree, such as asthma, foreign body, or new growth, innocent or malignant. Bronchiectasis also arises secondary to lung abscesses and empyemata, especially those in which fibrosis extends into the lung.

The addition of an infective process in either the primary or secondary varieties leads to more rapid progress of the disease and results in further weakening and disorganization of the structures composing the walls of the bronchi. This

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may result in considerable deposit of fibrous tissue in the bronchial walls when the infection is subacute or chronic, whereas, in the more acute types the spread may occur into the adjacent lung, causing abscess formation or even gangrene. Further, in chronic cases, persistent presence of infective secretions in the bronchial tubes is liable to initiate repeated attacks of broncho-pneumonia and often results in the spread of the disease to adjacent portions of the same lung or the base of the opposite lung.

Ulceration of the mucous membrane of the bronchi or the excessive formation of granulation tissue may cause hæmoptysis, which is commonly of the intermittent type, but sometimes results in rapid death from a large hæmorrhage.

Symptoms and signs are so well recognized as not to merit description here.

TREATMENT

As an indication of the proportion of patients with unilateral or unilobar bronchiectasis Jex-Blake, analysing the autopsy findings in 105 patients, has shown that the disease was still unilateral in 61 and confined to one lobe in 34 patients. This shows the high proportion of patients, subjects of this disease, who could, from the localization of the disease, have been candidates for some form of surgical procedure. The immediate cause of death was bronchopneumonia and exhaustion in 76 patients, hæmoptysis in 5, and cerebral or cerebellar abscess in 15. The high proportion of brain abscesses is significant, particularly as operative procedures have so often in the past been held responsible for this fatal complication, and in view of the fact that none of these patients had been submitted to any surgical procedure.

A very brief résumé of the methods of treatment which have been adopted at various times will give some indication of the value of these different measures.

NON-OPERATIVE PROCEDURES

1. **Drugs.**—Simple medical treatment consists of rest and the use of certain drugs intravenously, by inhalation, or by mouth. These consist of arsenical compounds, given by intravenous or intramuscular injection, for their specific effect on spirochetes, which are not rarely found in the sputum in this disease; lipiodol, which is generally given into the bronchi by intratracheal instillation; and such other drugs as emetine and creosote given by mouth. It is very doubtful if the effect of any of these is more than temporary, and no claim has ever been substantiated as to their permanent curative value.

2. **Postural Drainage.**—Temporary improvement always results from such measures as postural drainage, in which the patient is placed in such a position, found after trial, as will most easily empty the secretions in the bronchi. The position is taken up morning and evening and in many cases will enhance the patient's comfort during the intervening periods.

3. **Bronchoscopic Aspiration.**—This also is of considerable temporary value, often improving the general condition of the patient to a marked degree. The value of instillations of antiseptics through the bronchoscope is doubtful. In the presence of a foreign body or of stenosis, the value of bronchoscopy is unquestionable. It must be remembered, however, that removal of a foreign body which has been *in situ* in a bronchus for a considerable period and has caused gross

dilatation of the tubes in the obstructed portion of the lung will not necessarily lead to recovery. In other cases bronchoscopy can only be regarded as a more efficient form of drainage than that of posture, and any fresh infection will tend to light up the process in the involved area of the lung again. Radiological examination after lipiodol injection, following a course of bronchoscopy, in nearly all except very early cases shows no diminution in the dilatation.

OPERATIVE PROCEDURES

Operative measures may be divided into two groups: (1) Collapse methods; and (2) Radical extirpation of the diseased tissues.

1. Collapse Methods

All collapse measures have certain disadvantages due to the fact that the diseased tissue still remains, but it is possible that the activity of the infection may be kept in check in many cases by the approximation of the bronchial walls and the avoidance thereby of stagnation, while the compression is maintained.

Artificial Pneumothorax is the most simple method of general compression of the lung, and has been used freely in the treatment of bronchiectasis. In early cases, and especially where the bronchial walls are relatively soft, it may prove of considerable value, but it is unlikely, even when pleural adhesions do not prevent the establishment of pneumothorax, that it could collapse the thickened, rigid, dilated bronchi found in the well-established disease: in fact, the mediastinum is much more likely to be displaced than the bronchi collapsed if the pressure of the air within the pleura is increased.

In cases in which, as a result of artificial pneumothorax, the sputum has almost disappeared, when the pneumothorax is discontinued it is not uncommon to see the expectoration increasing again *pari passu* with the expansion of the lung. Further, prolonged maintenance of an artificial pneumothorax is often impossible owing to the development of a pleural effusion or to the pneumothorax cavity contracting in spite of regular refills with air.

Oleothorax, or the replacement of the air by sterile oil, is claimed by some authorities to overcome some of these objections, but the proportion of patients in which permanent improvement can be expected by this method is small, and the oil has the added disadvantage of causing dense pleural thickening, which may prevent any subsequent radical operation, or, at the least, the post-operative expansion of the remaining lobe.

Phrenicectomy has been extensively used for bronchiectasis, with varying results. There is no doubt that in early bronchiectasis—for example, that type secondary to basal pulmonary abscess—all symptoms can be made to disappear permanently. In other cases no change is to be noted, and occasionally the operation may result in angulation of the bronchi and cause interference with the drainage. Examination of the diaphragmatic movement under the X-ray screen in cases of bronchiectasis almost invariably shows limited mobility due to spasm induced by irritation of the infected neighbouring lobe. This may be the cause of poor evacuation of secretions from the lower bronchial tubes; in many cases diaphragmatic paralysis will diminish dyspnœa due to this cause and will allow the unimpeded contraction of the powerful abdominal muscles during cough to

result in more complete evacuation of the contents of the dilated basal tubes. Thus dyspnœa on exertion may be less evident, sputum and fœtor be diminished, and definite improvement follow.

Thoracoplasty has been widely used for bronchiectasis, and the results appear to be variable. It is unlikely that the relatively restricted thoracoplasty used by Sauerbruch for tuberculosis could produce sufficient collapse to free patients of symptoms. Hedblom and others have advocated wide removal of the ribs almost to the extent of complete decostalization by multiple-stage operations. By this more radical procedure he claims a fair proportion of success, but, as is mentioned earlier, the results cannot be expected to be so satisfactory as those following removal of the diseased area. However, in cases of almost complete unilateral bronchiectasis thoracoplasty is still the operation of choice and gives a definite probability of considerable amelioration. Its value where the disease is localized is problematical. Thoracoplasty should invariably be performed in two or more stages, preceeded by a phrenicectomy.

Pre-operative treatment should be carried out in the same way as for lobectomy.

2. Radical Operations

Cautery Pneumectomy was originally devised by Graham with the idea of removal of the diseased portion of the lung by repeated cauterizations. The value of the operation appears to be largely due to the production of efficient drainage in suppurative conditions of the lung. In definite cases of bronchiectasis unassociated with the formation of large cavities, we have not found this operation satisfactory. Its author now advises its use in bronchiectasis associated with multiple lung abscesses and in chronic lung abscess with secondary bronchiectasis. In those cases secondary to foreign-body inhalations, especially if associated with bronchopleural fistula or empyema, and who are suffering from the effects of prolonged sepsis, the pulmonary drainage produced by cauterization may tide them over a critical period. Summing up the value of cautery pneumectomy, Graham now states that "the operation can be recommended to those suffering from unilateral bronchiectasis who have not responded well to the simpler forms of therapy, for whom thoracoplasty is either not indicated for various reasons or has failed to relieve the symptoms and upon whom the performance of a lobectomy, although desirable, is unwise or technically impossible."

One-stage Lobectomy is dealt with fully below.

ONE-STAGE LOBECTOMY FOR BRONCHIECTASIS

Removal of a lobe of lung the site of bronchiectasis has been the ideal aim of surgical treatment for many years, and it is surprising to find in how large a proportion of patients the disease may be relatively advanced in a single lobe without gross disease in other parts of the lung. When the disease is confined within these limits the removal of the infected area should cure the patient if he survives operation and his immediate post-operative period.

Fear of widespread infection of the pleura and a mobile mediastinum have deterred the majority of thoracic surgeons from attempting one-stage lobectomy. As a result operations with two or more stages were performed, the earlier stages

with the object of closing off the upper part of the chest by adhesions and causing thickening of the pleura in the neighbourhood of the mediastinum. The largest series in this group was published by Lilienthal, with forty-two cases and a mortality of 64·3 per cent. Alexander, using a different technique, has much improved the results, with a mortality of 16·6 per cent in his first twelve cases, but this operation entails removal of several ribs, with a subsequent deformity of the chest.

The one-stage method was first tried out in a short series of eight cases by Brunn, and later slightly modified by Shenstone. Most one-stage lobectomies have been performed on these same principles.

DIAGNOSIS AND INDICATIONS

It is essential to ensure that the disease is localized to one lobe or to the middle and lower lobes on the right side. This can be definitely determined by radiological examination following lipiodol intratracheally, but this examination should be carried out not only antero-posteriorly but laterally, and if necessary obliquely as well, and of course both lungs should be examined. In one case in this series when this was impossible owing to preliminary treatment by pneumothorax, the disease has been shown subsequently to involve the lower portion of the upper lobe.

It does not appear generally justifiable to advise lobectomy where definite disease can be demonstrated in the opposite lung, as there is not only a greater post-operative risk but there is a great probability of the disease extending. In unilobar bronchiectasis there appear to be two main groups in which to advise operation: (1) Patients who expectorate definite quantities of pus daily, especially when it is offensive in odour; and (2) Patients who have repeated hæmoptyses with or without offensive sputum. The latter group are more favourable as infection is usually less intense. Those in whom bronchiectasis is secondary to neglected pulmonary abscess are also suitable, but when empyema, whether primary or secondary, has occurred, the operation may offer considerable technical difficulty from firm pleural adhesions.

Repeated examination of the sputum should be carried out to eliminate the presence of tubercle bacilli.

It is probable that lobectomy will be recognized in the near future as the ideal treatment for the thick-walled chronic lung abscess, especially those associated with localized bronchiectasis.

PRE-OPERATIVE TREATMENT

The preparation of the patient is of very considerable importance, and steps should be taken to raise the local and general resistance to the greatest possible degree; this is attained by the following measures.

1. **Postural Drainage.**—The regular adoption of postural drainage unquestionably improves the condition of the patient by diminishing the quantity of the sputum and, by the improved drainage, the virulence of the organisms in the purulent discharge. A similar result can be obtained by placing the patient regularly in a creosote chamber, which induces deep coughing. These methods may be combined.

2. **Preliminary Bronchoscopy.**—Aspiration via the bronchoscope is certainly more effective than postural drainage, but, although a minor procedure, is not so well tolerated as a pre-operative measure.

3. **Vaccine Therapy.**—In the great majority of these cases a vaccine has been prepared from the sputum and each patient has been given three increasing doses at weekly intervals before operation. The value of this measure is difficult to assess, but it is possible that it raises the patient's resistance and may help thereby to limit the effect of aspiration into the other lobes and to increase pleural resistance.

4. **Nose and Mouth Examination.**—Complete examination of the upper air-passages, including sinuses and teeth, is essential, and any obvious focus of infection should be eradicated by suitable treatment.

5. **Artificial Pneumothorax.**—In all cases where extensive pleural adhesions do not prevent its accomplishment, artificial pneumothorax is induced one week before operation. This is done for two purposes: (*a*) There is much less pulmonary movement when the pleura is opened and therefore less upset to the patient and anæsthetist; and (*b*) It tends to prevent accumulation of secretions in the affected lobe up to the time of operation. (If pneumothorax is produced only a few days before the major procedure, it neither prevents rapid expansion of the remaining portion of lung nor does it cause pleural thickening.)

6. **Phrenic Nerve Operations.**—No procedure is carried out on the phrenic nerve either before or at operation. Although temporary paralysis of the diaphragm done as a preliminary may make the operation technically easier, the movements of the diaphragm are of considerable importance in aiding expansion of the remaining lobe in the post-operative period, and its paralysis can conceivably delay this to a definite degree. Moreover, crushing at the time of operation may open up a passage for organisms through the mediastinal pleura. In cases in which the remaining upper lobe is firmly attached by adhesions, a late phrenic evulsion will assist in closing a residual basal empyema, and is reserved, for this purpose, to those cases requiring it.

7. **General Preparation.**—This consists of the administration of glucose by mouth for several days and, in addition, per rectum for the day preceeding operation. Furthermore, it is a wise precaution to group the patient's blood in preparation for a possible transfusion.

ANÆSTHESIA

(By Dr. IVAN W. MAGILL)

Certain points require special consideration in lobectomy.

1. **Preliminary Medication.**—This should be sufficient to ensure the comfort of the patient and facilitate induction without incurring respiratory depression in the post-operative period. The most satisfactory combination is a suitable dose of omnopon (up to $\frac{1}{3}$ gr.) and scopolamine (up to $\frac{1}{150}$ gr.) administered forty minutes before operation, followed by a minimum basal hypnotic dose of a quick-acting barbiturate, such as nembutal or evipan. The barbiturate is given intravenously just before induction.

2. **The Anæsthetic.**—Rapidity of elimination and absence of toxic effects make nitrous oxide and oxygen the anæsthesia of choice. Should any supplementary

agent be required, chloroform alone is permissible, owing to the use of diathermy. For the same reason, ether, ethylene, or other inflammable agents are contra-indicated.

3. **Method of Administration.**—Any efficient gas-oxygen machine can be used. A water manometer on the apparatus is an advantage, as it is more sensitive than the mercurial or mechanical type of pressure gauge. The anæsthetic can be administered throughout with a close-fitting facepiece, but this procedure involves certain risks: (*a*) The patient lies on the sound side and, in this position, unless constant positive pressure is maintained, secretions may be dislodged into the trachea and thence into the sound lung during manipulation of the affected lobe; (*b*) Unless an undesirable depth of anæsthesia is maintained, reflex closure of the glottis may occur during traction on the pulmonary root. Both these risks can be eliminated by intubation anæsthesia combined with partial occlusion of the bronchus on the affected side by means of a coudé gum-elastic catheter.

For intubation, rubber tubes are used, the calibre being sufficient to permit to-and-fro breathing through the lumen. When no contra-indication exists, the rubber tube is passed through the nose owing to the ease with which this manœuvre can be carried out in the majority of cases. Anæsthesia being established, the coudé catheter is passed through the glottis with the aid of a laryngoscope and stilette. To ensure entry into the bronchus, the tip of the catheter is kept in close contact with the lateral wall of the trachea by means of the stilette. When practicable, this form of anæsthesia provides the safest operating conditions: (*a*) On opening the pleural cavity, when the lung is free it can be seen to be deflated, and is therefore more easy to handle; (*b*) Secretions can be removed through the catheter by suction, as often as necessary; (*c*) Continuous positive pressure is not essential, and on this account there is less impediment to the right side of the heart.

OPERATIVE TECHNIQUE

Incision.—A curved incision is made overlying the seventh interspace and curving upwards posteriorly. The muscular layers are divided similarly to the mid-axillary line. When the ribs are exposed an incision is made in the intercostal space, a small Tuffier retractor inserted, and the incision widened. Posteriorly, the seventh rib is divided subperiosteally behind the angle, and a segment of rib ¾ in. removed. (The removal of this small portion, rather than division only, definitely limits post-operative pain.) The intercostal vessels are then ligatured in two places, and the incision carried backwards between the ligatures and forward to the mid-axillary line.

It is essential, in view of the highly infective nature of the contents of these infected lobes, to pay particular attention to the protection of the muscular chest-wall. In addition, therefore, to the application of tetra cloths to the skin as soon as the pleural cavity is exposed, the whole of the opening is lined with gauze saturated with 1–1000 flavine, which is retained in position for the remainder of the operation. Wide retraction is now carried out.

In a large proportion of cases adhesions are present, most commonly over the diaphragm, but in many cases posteriorly and between the lobes. In some cases adhesions are generalized, and in many cases very dense. (In two cases the attachments of the lobe to the lower posterior part of the chest were so dense and vascular that it was necessary to secure the hilum before they were cut.)

When the adventitions adhesions are all freed, the lobe is lifted upwards and the pulmonary ligament is exposed. In almost every case this will be found to contain vessels of appreciable size, and it should therefore be divided between forceps. Ligatures are then applied and the lobe is free and ready for control of the pedicle. Occasionally the normal interlobar space may be absent or partially defined, and in these cases it is necessary to divide the bridge of lung tissue, the raw area on the remaining lobe being sutured later.

Removal of the Lobe.—Before application of the lobectomy tourniquet (*Fig.* 193) it is essential to pack off the pleura carefully to avoid soiling when the

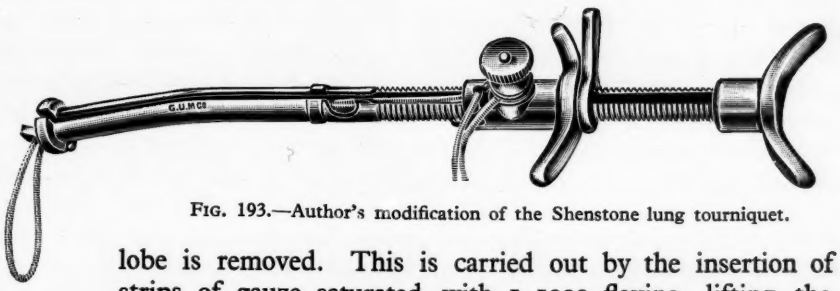

FIG. 193.—Author's modification of the Shenstone lung tourniquet.

lobe is removed. This is carried out by the insertion of long strips of gauze saturated with 1–1000 flavine, lifting the lobe to be removed by holding forceps while this is accomplished. A strip of gauze that has been wrung out in 10 per cent cocaine is now wrapped around the hilum of the affected lobe for a short time to anæsthetize nerve-endings there and prevent reflex effects. The loop of the tourniquet is dropped over the

FIG. 194.—Placing of tourniquet around lobe, to be followed by packing off remainder of chest.

lobe and adjusted accurately to the hilum. (*Fig.* 194.) The tension on the silk can be accurately determined before it is locked in position. In our experience the application of a second tourniquet is either impossible or unnecessary. In

those cases in which there may be much retention of purulent secretions in the bronchi, the lobe is generally found to be solid and therefore the application of a second tourniquet is impossible, whereas in those cases in which the second tourniquet can be applied, the contents of the bronchi are minimal and its application is unnecessary. Careful swabbing during the division of the hilum is always essential.

The hilum is divided distal to the tourniquet with scissors, the lobe removed, and any projecting bronchi are cut short. The division at the hilum was carried out by diathermy in the early cases, but this does not appear to have any advantages and may result in necrosis of the cartilage of the bronchial stumps. Novarsenobenzol in solution is applied to the stump in order to destroy any anaerobic organisms which may be present. The lumina of the main bronchial divisions in the stump are carefully swabbed with pure carbolic or 30 per cent silver nitrate to destroy the mucous membrane.

Suture of Stump.—The stump controlled by the tourniquet is now sutured by the insertion of a series of mattress sutures (*Fig.* 195). It is advisable to use

FIG. 195.—Method of suturing stump by mattress sutures closing bronchi and sealing vessels. Inset shows suture of edges over bare area of stump.

chromic gut with a needle at each end of the suture, and to commence the sutures at the lower end. The ends of these sutures are kept long and held in forceps until the whole surface of the stump is controlled. The lock on the tourniquet is released and the tension gradually diminished by the assistant. On signs of any bleeding the tension is increased while the area is controlled by the insertion of another suture. When the stump is secure the tourniquet is removed and the stump oversewn, where possible, by the fringe of pulmonary tissue.

In the majority of cases no attempt has been made to attach the stump to the adjacent lobe owing to the possibility of infecting this from the passage of sutures through the septic pedicle into the normal lung above, and if left alone there is

every probability of rapid adhesion from expansion of the upper lobe over the stump.

Positive pressure induced through the intratracheal catheter or the induction of cough will disclose any leakage in the stump, which when present is controlled by further suture.

Closure of Chest.—This is attained by drawing the ribs together by three or four pericostal sutures passed through the middle of the interspace above and below the incision to avoid damage to the intercostal vessels and nerves. The intercostal muscles and the deep and superficial muscles of the chest wall are sutured with continuous catgut. Three or four deep tension stitches of strong silkworm gut are inserted, and the skin closed by continuous silk.

Drainage.—In the first case in this series (1929) in which lobectomy was performed, without any form of tourniquet on the stump, the chest was closed completely. Subsequently collections of fluid without gross infection were aspirated on ten occasions. Later, following Shenstone's technique, an intercostal tube was invariably inserted upwards to the stump through a cannula introduced below the main incision. In the course of these cases it was often found that there was considerable difficulty in getting the intercostal tubes to function adequately, and in many cases collections of fluid, often sterile, have had to be aspirated from different pockets in the pleura. The essential to be attained in the early stage is full expansion and adhesion of the upper lobe, and it seemed to us that the value of the intercostal tube was doubtful. The second condition which appeared to call for immediate drainage is that of high-tension pneumothorax should the stump leak. This risk again, from our experience, we believe to be exaggerated. If the stump leaks in the first twenty-four hours there will be definite evidence of surgical emphysema to warn those in attendance of the fact that air is escaping into the pleura, for it is quite impossible to suture the chest sufficiently firmly to prevent the escape of air under tension from the pleura to the extrathoracic tissues. Leakage from a bronchial fistula at a later stage does not offer any serious risk, as it is only into the area around the stump and is shown by the patient's coughing up pus from a residual cavity around the stump. Likewise, in view of the modern treatment of extensive infected pleural effusions by aspiration in the early stages—i.e., before adhesions have formed—it appeared reasonable to treat these patients on similar lines.

In six cases treated on these lines the chest wound was completely closed. Either in the operating theatre or immediately on the patient's return to bed, a needle attached to a pneumothorax apparatus was inserted into one of the upper interspaces anteriorly and as much air as could be obtained was aspirated. Estimation of the intrapleural pressure immediately disclosed any leakage from the lung. The one disadvantage of this method was that it necessitated repeated and early aspiration of the chest. This had a disturbing and wearing effect upon the patient, and latterly we have again altered the technique by introducing an intercostal tube which is closed by a spigot, then aspirating the air from the upper pleura with a pneumothorax apparatus.

When the patient has recovered consciousness in bed, the tube is connected with an underwater tube, care being taken to allow no air to enter the chest during this procedure, and fluid from the pleura can be evacuated by releasing the controlling clip as and when required.

The essential factor is to get full expansion and adhesion of the remaining lobe before evidence of infection shows itself, so that, subsequently, the most serious eventuality is a localized empyema cavity.

The aspiration of air from the upper chest immediately after operation appears to result in more even expansion of the upper lobe and less liability to the formation of residual pleural pockets requiring aspiration.

POST-OPERATIVE TREATMENT

Blood Transfusion may be required in some cases, and although the necessity appears to diminish with increasing experience of the operation it still depends to a large degree upon the pathological conditions found. Thus, for cases with extensive and firm adhesions which result in a considerable degree of oozing from the chest wall, blood transfusions are more often required, and as it is impossible to determine these with certainty beforehand, every patient should be grouped as a pre-operative measure. (N.B.—Although the production of pneumothorax will determine the presence of wide adhesions, dense adhesions are occasionally found in the costo-vertebral groove and to the pericardium, which may not be disclosed by X-ray examination.)

In every case there will be a good deal of blood-stained discharge from the pleura in the course of the two days following operation, and in all cases in which there would appear any doubt about the immediate necessity of post-operative transfusion it should be performed.

General Post-Operative Measures.—The usual routine administration of fluids—per rectum, subcutaneously, or intravenously—is carried out according to the necessities of the case. Cardiac stimulants, coramine, cardiazol, etc., are administered when necessary, and occasionally the respiratory tract may require stimulation by the administration of CO_2 and oxygen.

The patient on recovery from the effects of the operation and anæsthetic is nursed in the sitting posture to allow free use of the lower intercostal muscles and diaphragm.

The Condition of Pleura at Operation.—In 38 patients the pleura has been free at the time of operation—i.e., the remaining lobe was not adherent to the chest-wall. In 17 of these patients the affected lobe had definite adhesions, varying from those in which the adhesions could be separated by blunt disection to those which required division with sharp instruments. In the remainder adhesions were generalized over all lobes, varying considerably in density.

Bronchial Fistula.—The formation of a bronchial fistula is, in our experience, common, and usually occurs on about the tenth day. It is not as a rule of any particular significance, for if the intercostal tube is still draining no risk is entailed, and if the chest-wall has healed it results in the expectoration suddenly and temporarily increasing in quantity from evacuation of the small residual cavity around the stump.

Treatment of Late Empyema.—The residual infected cavity usually heals without further drainage than that established by the intercostal tube, but in a few severely infected cases rib-resection may be necessary. By the time that this is required, the remaining lobe or lobes are adherent to the chest-wall, the only

complication being the presence of the bronchial fistula. The bronchial opening, being deep, tends to close spontaneously as the cavity contracts, and in only one patient has the fistula persisted over three months.

Late Phrenicectomy.—This was performed in eight cases in order to close the residual cavity and bronchial fistula, and was successful in its effect in seven patients.

ANALYSIS OF CASES (*see Table*, pp. 322–325)

This series consists of 48 consecutive cases, of whom 23 were men and 25 women. The disease occurred in the lower lobes in 47, and in the upper lobe in 1 patient. The lesion was situated in the right lung in 14 patients, was bilateral in 1, and in the remainder was situated on the left side. In two patients the right middle and lower lobes were involved and required resection.

Six patients were over 40 years of age, the youngest was 9 and the oldest 49 years.

Predominant Clinical Features.—Hæmorrhage was the predominant symptom in 11 patients, whereas in the remainder fœtid purulent expectoration was the chief indication for operative procedure, although hæmoptysis accompanied this symptom in a further 20 cases.

Post-operative Drainage.—This was carried out by intercostal tube in 42 cases. No post-operative drainage was carried out in 6 patients. Of these, 4 healed per primam, following aspiration, although in a few other drained cases intercostal drainage ceased early, the intercostal tube was removed, and the effusion was aspirated subsequently. In no case has the main wound broken down and allowed free communication between the pleura and the exterior. In the great majority the main wound has healed per primam.

Mortality.—Seven patients have died subsequent to lobectomy, four within the first week and three later. Of the four early post-operative deaths, three succumbed to shock and hæmorrhage and one to suppurative bronchitis of the opposite lung. Of the three late deaths, one resulted from cerebral abscess four weeks after operation when the local condition consisted of a small residual sinus, and of the other two, one three months after operation from a spontaneous pneumothorax due to unsuspected tuberculosis on the unoperated side. This latter patient, however, still had a large empyema cavity remaining on the operated side. The third, a case of bilateral disease, died five months after operation with a residual empyema, tuberculosis of the opposite lung, and a terminal streptococcal effusion in the opposite pleura and pericardium.

Analysis of the Surviving Patients.—These number 41, of whom 6 are still in hospital and convalescent. Excluding these, there remain 35 patients who have been discharged from hospital at varying periods from five years to a few weeks, and, with the exception of one patient, are completely healed. This patient still has a small residual empyema cavity with a persistent bronchial fistula of over a year's duration, and may later require a plastic operation for its closure. Six of the remaining 34 patients still have some residual symptoms, all of much diminished degree. In one, in whom the operation was performed for bronchiectasis associated with a sinus in the chest-wall and in whom repeated severe hæmorrhage was the indication for surgical interference, there has been a recurrence of a minor degree

ANALYSIS OF CASES OF BRONCHIECTASIS TREATED BY ONE-STAGE LOBECTOMY

NAME	SEX AND AGE	SIDE	SITE	EXPECTORATION	HÆMOPTYSIS	DATE OF OPERATION	STATE OF PLEURA	DRAINAGE	LATE PHRENIC-ECTOMY	REMARKS
1. A. L.	F 17	L.	Lower	30–60 c.c.	60–90 c.c.	17.4.29	Pleura free. No adhesions	Intercostal	No	No symptoms. Quite fit and well
2. M. D.	F 32	L.	Lower	Nil	Severe. Repeated	29.3.30	Densely adherent	Intercostal	Yes	Occasional small hæmorrhages followed by expectoration of thread suture from stump. 20.4.34
3. G. T.	M 19	L.	Lower. Adhesions	360–450 c.c.	Nil	12.2.31	Adhesions to diaphragm and pericardium. Upper lobe free	Intercostal	Yes	60–80 c.c. purulent sputum daily, but working
4. L. Y.	M 24	L.	Lower	60 c.c.	120 c.c.	25.2.31	Dense adhesions to upper lobe. Old A.P. Upper lobe free	Intercostal		No symptoms
5. A. B.	M 21	L.	Lower	60–90 c.c.	Considerable	22.4.31	Pleura free	Intercostal (1) Secondary (2)	No	Has recently developed T.B. 20.4.34
6. E. M.	F 17	L.	Lower	300–450 c.c.	Nil	3.6.31	Lower lobe densely adherent to upper	Intercostal	No	No symptoms. Gained 1 stone. 25.4.34
7. E. S.	M 30	L.	Lower	150–210 c.c.	Severe. Persistent	1.7.31	Both lobes densely adherent	Intercostal	No	Died 2.7.31. Cardiac failure
8. J. H.	F 14	L.	Lower	30–60 c.c.	Recurrent	4.7.31	Dense adhesions throughout	Intercostal	Yes	No symptoms. Gained 1½ stone
9. W. E.	M 24	L.	Lower	120 c.c. Purulent	Nil	2.3.32	Diaphragmatic adhesions. Pleura free	Intercostal	Yes	No symptoms
10 .E. S.	M 24	L.	Lower	240 c.c.	Copious	28.7.32	Dense adhesions of lower and upper lobes	Intercostal (1) Secondary (2)	No	No symptoms. Gained 1 stone. 2.5.34
11. B. H.	F 31	L.	Lower	60 c.c.	Repeated	24.8.32	Diaphragmatic adhesions. Upper lobe free	Intercostal (1) Secondary (2)	No	Died 28.9.32. *Autopsy*. Cerebral abscess R. temporo-sphenoidal lobe. Small bronchial fistulous tract to skin
12. J. M.	M 9	R.	Middle and	30 c.c.	600–1200 c.c.	7.9.32	Moderate adhe-	Intercostal	No	No symptoms. 11.4.34
14. W. G.	F 45	R.	Lower	60–90 c.c. Purulent	Nil	27.12.32	Pleura free	Intercostal	No	No symptoms
15. E. H.	F 36	L.	Upper	15 c.c.	Small	25.1.33	Both lobes adher-	Intercostal		No symptoms

12. J. M.	M 9	R.	Middle and	30 c.c.	600–1200 c.c.	7.9.32	Moderate adhe-	Intercostal	No	Small fistulous tract to skin No symptoms. 11.4.34
14. W. G.	F 45	R.	Lower	60–90 c.c. Purulent	Nil	27.12.32	Pleura free	Intercostal	No	No symptoms
15. E. H.	F 36	L.	Upper	15 c.c.	Small	25.1.33	Both lobes adherent	Intercostal		No symptoms
16. D. H.	F 16	L.	Lower	Repeated attacks of pneumonia	180 c.c.	22.2.33	Dense adhesions of both lobes	Intercostal	No	No symptoms (*See Fig.* 212)
17. E. G.	M 38	L.	Lower. Cylindrical Saccular	40–60 c.c. Fœtid	Once	15.3.33	Incomplete fissure; otherwise free	Intercostal	Yes	Slight degree of bronchitis in opposite lung. 1 oz. frothy sputum daily, otherwise no symptoms. 25.4.34
18. C. R.	F 29	R.	Lower	240 c.c.	Nil	22.3.33	Both lobes densely adherent	Intercostal (1) Secondary (2)	Yes	Residual bronchial fistula. 30 c.c. purulent sputum (*See Fig.* 211)
19. J. D.	F 21	R.	Lower	30 c.c.	Occasional	5.4.33	Pleura free	Intercostal	No	Healed and no symptoms
20. J. J.	M 31	R.	Cavities middle and lower lobes	800 c.c.	Nil	10.4.33	All lobes densely adherent	Intercostal	No	Died 11.4.33. *P.M.* Death from cardiac failure. Spleen of septic type. Nil otherwise
21. E. M.	F 34	R.	Lower	90 c.c.	Nil	13.5.33	Pleura free	Intercostal (1) Secondary (2)	Yes	Well healed. About 1oz. sputum daily. Steadily gaining weight. 21.3.34
22. B. T.	M 20	L.	Lower	30–60 c.c.	Small	8.6.33	Pleura free	Intercostal (1) Secondary (2)	No	Died 11.9.33. *P.M.* Several caseous T.B. foci R. lung. Spontaneous pneumothorax. Residual empyema cavity L.
23 W. T.	M 11	R.	Lower	Intermittent	Nil	10.7.33	Affected lobe adherent to sinus, otherwise free	Intercostal	No	No symptoms
24. T. D.	M 38	L.	Lower	180–360 c.c.	Nil	12.7.33	Pleura free	Intercostal	No	No symptoms
25. L. C.	F 30	L.	Lower	120 c.c.	Up to 300 c.c.	26.7.33	Pleura free	Intercostal	No	No symptoms. Gained 4 lb. 31.3.34

Continued on next page

ANALYSIS OF CASES OF BRONCHIECTASIS TREATED BY ONE-STAGE LOBECTOMY—*continued.*

NAME	SEX AND AGE	SIDE	SITE	EXPECTORATION	HÆMOPTYSIS	DATE OF OPERATION	STATE OF PLEURA	DRAINAGE	LATE PHRENIC-ECTOMY	REMARKS
26. E. M.	M 15	L.	Lower	120 c.c.	30 c.c.	2.8.33	Pleura free	Intercostal	No	No symptoms. Trace of sputum. 2.5.34
27. C. J.	F 33	L.	Lower	30 c.c.	Repeated	23.8.33	Pleura free	Intercostal		No symptoms
28. G. C.	F 17	R.	Lower	210 c.c.	Nil	30.8.33	Pleura free	Nil		6 c.c. mucoid sputum daily. Otherwise well. 4.4.34
29. C. W.	F 22	L.	Lower	30 c.c.	Repeated	27.9.33	Pleura free. Lobe adherent to diaphragm	Nil	No	No symptoms. Gained 4 lb.
30. R. A.	F 17	L.	Lower	60 c.c. Purulent	Occasional. Free	11.10.33	Lower lobe adherent. Upper free	Nil	No	No symptoms except some lassitude on working. 21.3.34
31. H. F.	M 23	L.	Lower	150 c.c.	Twice	11.11.33	Pleura free	Nil	No	No symptoms. Quite fit. Gained 10 lb. 18.4.34
32. H. K.	M 11	R.	Lower	Scanty	Nil	15.11.33	Pleura free	Intercostal	No	No symptoms. Gained 9 lb. 21.3.34 (*See Figs.* 206–210)
33. H. F.	M 30	R.	Lower	60 c.c.	Nil	22.11.33	Affected lobe very adherent. Other free	Nil		No symptoms
34. S. D.	M 34	R. and L.	Lower	60–90 c.c.	Severe. Frequent	27.11.33	Left lower lobe adherent. Upper free	Nil	No	Died 9.5.34 with residual empyema, T.B. of R. lung, resulting in streptococcal effusion in R. pleura and pericardium
35. J. W.	F 9	L.	Lower	90 c.c.	60 c.c.	6.12.33	Mediastinal adhesions	Nil	No	No symptoms. Well and gained 7 lb. 28.4.34 (*See Figs.* 196–199)
36. H. R.	M 38	R.	Lower	50–60 c.c.	Nil	13.12.33	Generalized adhesions	Intercostal (1) Secondary (2)	Yes	Very fit. Gained 1½ stone. No appreciable spu-
38. J. S.	M 23	L.	Lower	900–1800 c.c.	Repeated	5.1.34	Generalized adhesions	Intercostal		No symptoms
39. J. K.	M 46	R.	Middle and	90 c.c. foul	Once	17.1.34	Pleura free	Intercostal	No	Died 20.1.34. Suppurative bronchopneu-

							hesions	Secondary (2)		1½ stone. No appreciable spu-
38. J. S.	M 23	L.	Lower	900–1800 c.c.	Repeated	5.1.34	Generalized adhesions	Intercostal		No symptoms
39. J. K.	M 46	R.	Middle and lower	90 c.c. foul	Once	17.1.34	Pleura free	Intercostal	No	Died 20.1.34. Suppurative bronchopneumonia
40. S. T.	F 47	L.	Lower	60 c.c. green and offensive	Several	14.2.34	Pleura free	Intercostal	No	No symptoms. Soundly healed. Steadily gaining weight. 8.5.34
41. N. M.	F 43	L.	Lower	A little	Repeated	21.2.34	Pleura free	Intercostal	No	No symptoms. No hæmoptysis. States she "feels a different woman." 8.5.34
42. M. C.	F 49	R.	Lower	150 c.c. purulent. Repeated pneumonia	Nil	22.3.34	All lobes densely adherent	Intercostal	No	Died. Reactionary hæmorrhage from raw area of chest-wall
43. K. C.	F 18	L.	Lower	60 c.c.	Occasional. Slight	11.4.34	Pleura free. Lower lobe adherent	Intercostal	No	Still in hospital convalescent
44. M. F.	F 22	L.	Lower	60–90 c.c.	Frequent 300–600 c.c. about once a month	11.4.34	Pleura free	Intercostal	No	Healed—convalescent
45. A. L.	M 35	R.	Lower	30 c.c.	Two severe attacks	30.4.34	Pleura free. Very firm adhesions over lower lobe		No	Still in hospital. Small residual sinus, otherwise well
46. L.T .	M 36	L.	Lower	Small amount	Several attacks	2.5.34	Lower densely adherent. Upper partially adherent	Intercostal	No	Required retrograde removal of lobe. Old drained abscess and bronchiectasis. Sinus present. Still in hospital
47. D. H.	F 22	L.	Lower	210–240 c.c.	Nil	4.5.34	Pleura free. Lower lobe adherent posteriorly to diaphragm	Intercostal	No	Sinus healed. Convalescent. Still in hospital
48. C. G.	F 48	L.	Lower	30 c.c.	Repeated and severe	14.5.34	Pleura free except for fine band adhesions	Intercostal	No	Still in hospital—chest draining—condition good

of hæmoptysis on several occasions, two of which were associated with the separation of silk ligatures, which were used for the suture of the hilum. In four others there has been a persistence of a certain amount of purulent expectoration, although this has been markedly reduced in every case. All these show evidence of some

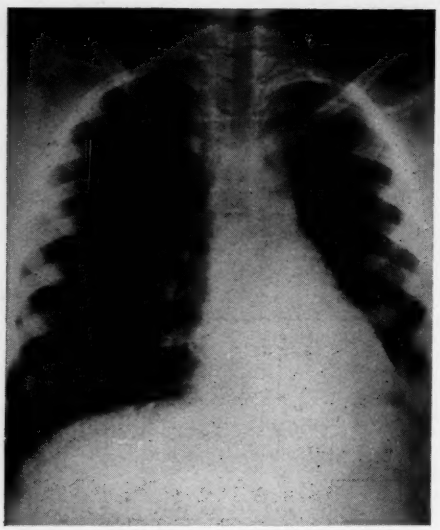

FIG. 196.—*Case* 35. Skiagram showing atelectasis of left lower lobe partially obliterated by cardiac shadow.

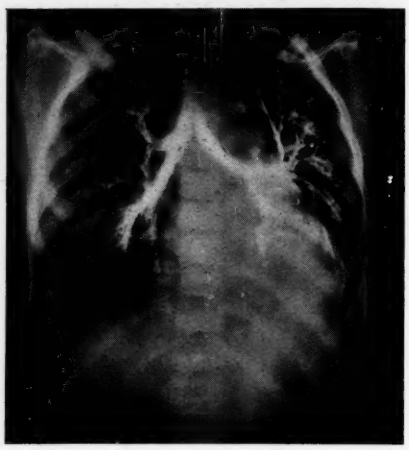

FIG. 197.—*Case* 35. Bronchogram showing gross bronchiectasis of whole lower lobe. Note also outward curving of upper lobe bronchi.

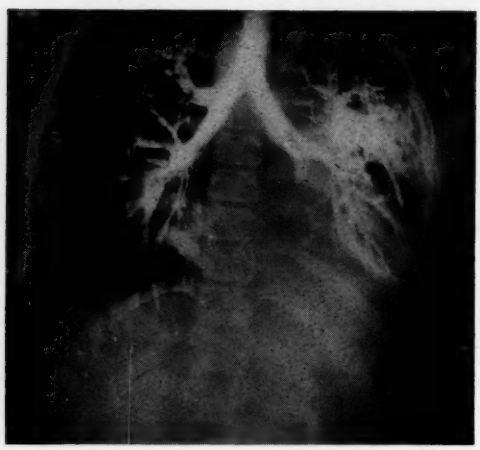

FIG. 198.—*Case* 35. Bronchogram after lobectomy. Note stump of lower lobe bronchus and inward displacement of upper lobe bronchi.

FIG. 199.—*Case* 35. Lateral bronchogram after lobectomy. Note complete filling of chest by expansion of upper lobe.

bronchiectasis in other lobes and would indicate a more careful investigation by lipiodol of the apparently unaffected portions of the lung. Thus it would appear advisable to carry out the investigation of each side independently, and particularly from the lateral view, if early stages of disease in the opposite side are to be eliminated with certainty.

The patient with the greatest quantity of purulent sputum following lobectomy now brings up about 60–90 c.c. daily, whereas before operation the quantity varied between 360 and 450 c.c. daily, and this has been shown to be due to bronchiectasis in the upper lobe of the same side. All these five are very definitely improved.

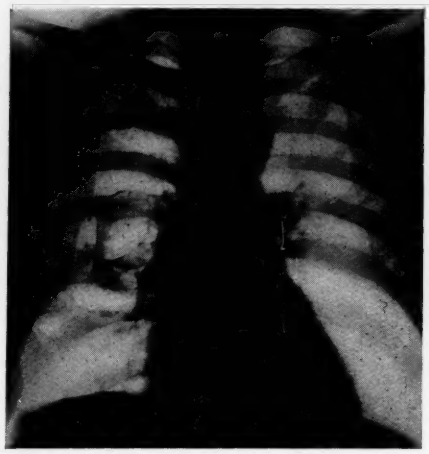

FIG. 200.—*Case* 36. Skiagram showing presence of portion of shell (old gunshot wound) and old fracture of seventh and eighth ribs.

FIG. 201.—*Case* 36. Lateral view showing shell fragment.

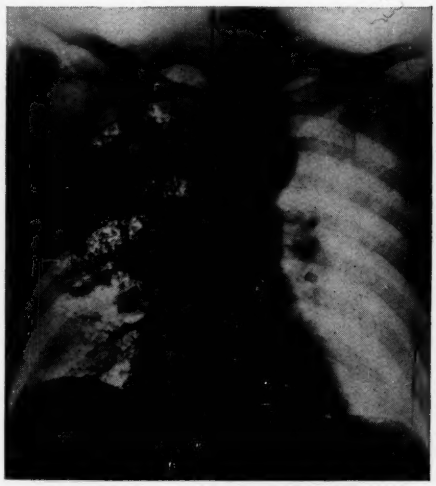

FIG. 202.—*Case* 36. Bronchogram showing cavitation around shell fragment and bronchiectasis of lower lobe.

FIG. 203.—*Case* 36. Lateral bronchogram showing cavitation.

The last of this group is a patient who has been symptomless for over three years and has recently developed tuberculosis of the opposite lung, which would appear to have no direct connection with the previous bronchiectasis and its eradication.

Twenty-nine patients are healed and symptomless, including one patient in whom malignant changes were found at the hilum of the bronchiectatic lobe.

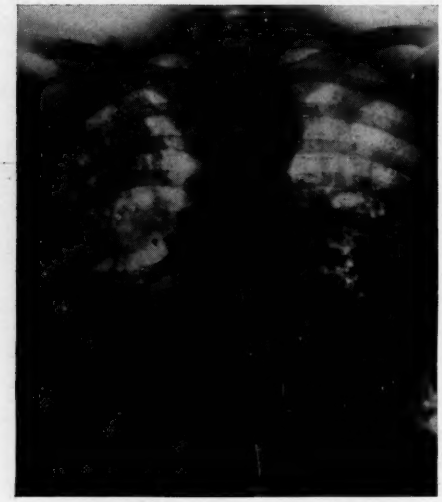

FIG. 204.—*Case* 36. Skiagram after lower lobectomy and late phrenicectomy.

FIG. 205.—*Case* 36. Gross generalized bronchiectasis secondary to cavitation due to the presence of a piece of shell from a gunshot wound during the War (the arrow indicates fragment of shell).

One other point might be considered here—namely, that in two patients the chest-wall adhesions were so dense laterally and posteriorly that the operation had to be modified. In both it was possible to free the area around the hilum where the adhesions were less firm and to thread the silk around the hilum, fix it in

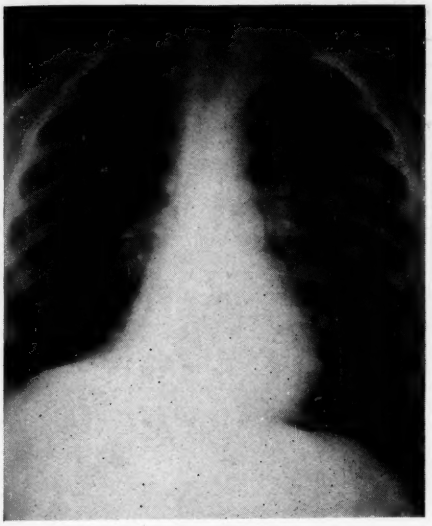

FIG. 206.—*Case* 32. Skiagram showing atelectasis of right lower lobe.

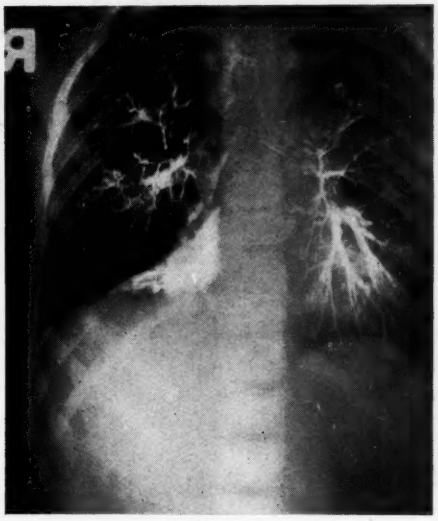

FIG. 207.—*Case* 32. Bronchogram showing area of bronchiectasis which comprises whole of lower lobe. Note the contraction in size and the relative expansion of upper lobe.

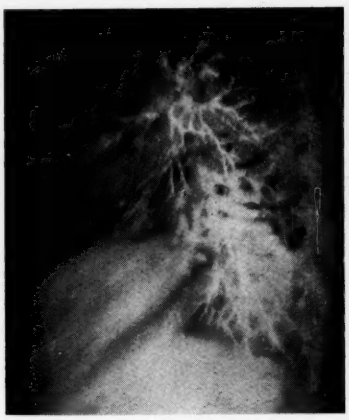

FIG. 208.—*Case* 32. Lateral bronchogram showing bronchiectasis. Note both sides are filled with lipiodol and outline of normal bronchi below area of bronchiectasis corresponds to filling of unaffected left side.

FIG. 209.—*Case* 32. Bronchogram after lobectomy.

the metal part of the tourniquet, and, after tightening, to divide the pedicle. The lobe was now dissected off the chest-wall without excessive bleeding. Modification of the tourniquet after the first case permitted an easier operation in the second case.

FIG. 210.—*Case* 32. Lower lobe after removal. Note contraction of lobe which is solid and shows gross dilatation of the bronchi.

Lastly, the operation here called one-stage lobectomy is meant to indicate that no attempt has been made to induce adhesions of the unaffected lobes to the chest-wall by a deliberate operation preliminary to the actual resection of the diseased lobe.

SUMMARY

1. An account of 48 cases of the so-called one-stage lobectomy for bronchiectasis is given.

2. Of these, 4 have died from conditions essentially associated with the operation itself, 3 have died later, 1 from cerebral abscess five weeks after operation, 2 from tuberculosis of the other lung, with terminal complications but each having a large residual empyema on the operated side, one three months and the other nearly six months after operation.

FIG. 211.—*Case* 18. Gross generalized bronchiectasis in right lower lobe.

3. Six patients, still in hospital, all show evidence of steady recovery.*

4. Of the remaining 35, 6 have some residual symptoms of slight degree compared with their original condition, and 29 are virtually symptomless.

5. This account does not include cases of lobectomy for malignant disease

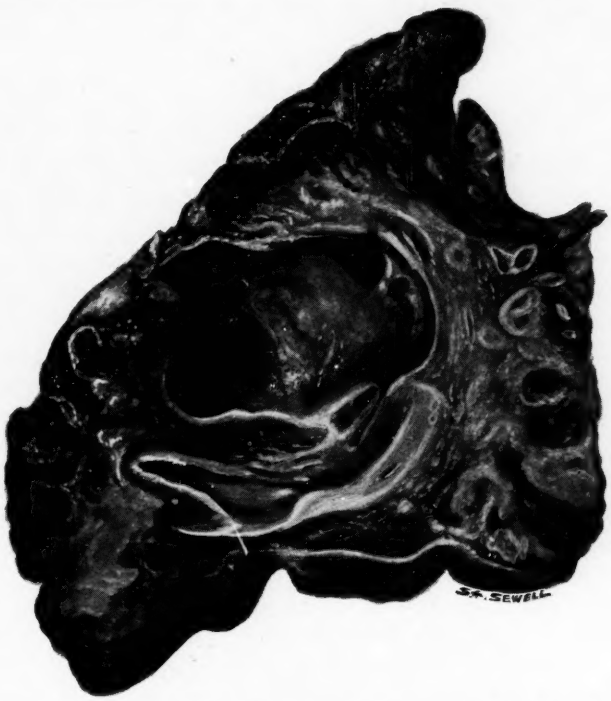

FIG. 212.—*Case* 16. Large bronchiectatic cavity with generalized bronchiectasis of left lower lobe.

except for one patient in whom bronchiectasis was the predominant lesion and an unsuspected carcinoma was disclosed at operation.

6. Lobectomy, performed in one-stage, appears to be a justifiable procedure, and should be the operation of choice for unilobar bronchiectasis.

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*All 6 patients recorded in the above paper as "in hospital" have been discharged healed and symptomless. Nine more patients have undergone lobectomy for bronchiectasis subsequently, with one death. Thus there is now a total of 57 patients, of whom 8 have died, giving a total mortality, early and late, of 14 per cent.

SARCOMA OF THE DUODENUM: REPORT OF A CASE

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TUMOURS of the duodenum are rare. Primary tumours are said to be commoner than malignant,[1] and of the latter, carcinomata are more common than sarcomata. The relative incidence of the type of malignant tumour in the intestine may be judged from figures collected by Mueller,[2] who in 521 cases of carcinoma found 41 occurring in the intestine, and in 102 cases of sarcoma only 1 instance of involvement of the bowel. Similarly, Nothnagel[3] found 243 cases of carcinoma of the intestine amongst 2125 carcinomata, 3 sarcomata of the bowel in 274 sarcomata, and 9 cases of lymphosarcoma of the bowel in 61 cases of lymphosarcoma.

Sarcomata may occur in any part of the bowel, but are more common in the small than the large intestine, where they are rare, with the exception of rectal ones, which are as common as those occurring in the small intestine. Libman,[5] in collecting 52 cases where the sites had been mentioned, found 15 in the duodenum, 18 in the jejunum, 2 in jejunum and ileum, 14 in the ileum, and 3 in the entire intestinal tract.

References in the literature to sarcoma of the duodenum are scanty. In addition to the cases collected by Libman[4]—which include all sarcomata of the small intestine, including the duodenum, cases have been described by Eiger,[5] Shapiro,[6] Sailer,[7] Barber,[8] Faykiss,[9] Terentyeff,[10] Mackenzie,[11] Angier and Fievez,[12] Bland-Sutton,[13] Freud,[14] Von Salis,[15] Giani,[16] Mostowska,[17] David,[18] Soli,[19] Pfundt,[20] and Laroque and Shiflett.[21] The majority of these cases have been published in journals to which, unfortunately, I have not been able to refer.

In view of the rarity of the condition it was thought to be of interest to put on record an additional case.

CASE REPORT

The patient, a married woman aged 51, was admitted to the Liverpool Royal Infirmary on June 9, 1933, complaining of epigastric pain and a swelling of the neck, each of two years' duration.

HISTORY.—The pain in the epigastrium had begun two years ago, but had been negligible till two months ago, when it became more severe. The pain was sharp and stabbing in nature and radiated along the costal margin to the left axilla, but not to the back. It lasted about fifteen minutes at a time, and was unrelated to food. The patient had suffered from vomiting for the last three months, the vomiting occurring before breakfast usually, and occasionally during the day. Vomiting would relieve the pain—the vomit did not contain food, was 'yellow liquid'—the quantity being about a pint. There was a doubtful history of blood in the vomit on two occasions. For the past three weeks the patient had been free from this symptom. The appetite had been poor lately. The bowels were regular. She suffered considerably from flatulence between meals. She had lost 22 lb. in weight in the last nine months. There was no urinary disturbance.

Apart from the digestive symptoms, the patient had noticed a swelling in her neck for the past two years, which, she thought, fluctuated in size. She also had been suffering from

nervousness and palpitations for the past six months. There was no history of dysphonia or dysphagia.

ON EXAMINATION.—She was a small, thin, pale woman and had evidently lost weight. There was no gross anæmia.

Thyroid.—There was slight enlargement of both lateral lobes, and an adenoma was present in the isthmus. The latter was 1½ in. in diameter, smooth, soft, fluctuating, and situated in the middle line. There were no eye signs of thyrotoxicosis nor tremors of the fingers.

Abdomen.—A small mass 2 × 1 in. was palpable in the right hypochondrium; it was not very hard, slightly tender, and one could get above it. The swelling was slightly movable, though it did not move on respiration. The swelling did not pass into the loin. It was dull to percussion. There was nothing else palpable in the abdomen. Rectal examination revealed no abnormality.

Cardiovascular System.—The pulse was 100 on admission. The blood-pressure was 210 mm. systolic and 170 diastolic. The heart was slightly enlarged; there was a systolic murmur at the mitral area with reduplication of the second sound there.

The respiratory and central nervous systems showed no gross abnormality.

Investigations.—Radiological examination of the gastro-intestinal tract showed gastroptosis with no delay and no evidence of organic lesion of the stomach or duodenum. There was some colonic stasis. A barium enema, in confirmation, revealed no colonic lesion.

Examination of the gall-bladder by Graham's method revealed a radiologically normal gall-bladder. X-ray examination of the neck showed no tracheal compression.

TREATMENT.—The patient was thought to be suffering from a toxic adenoma of the thyroid—apart from her abdominal condition—and was treated with Lugol's iodine 5 min. three times a day, and luminal ½ gr. three times a day, during the time she was being investigated.

In view of the presence of the tumour, it was decided to explore the abdomen. This was done on July 10 by Professor R. E. Kelly, under whose care the patient was. Under intratracheal anæsthesia administered by Dr. Bennett Jones, the abdomen was opened through a right paramedian incision. A swelling could be felt on the posterior abdominal wall. The stomach, omentum, and transverse colon were turned up and a tumour was made out in the neighbourhood of the third or transverse part of the duodenum, just beyond the centre.

On incising the peritoneum, the swelling was found to be partly within the duodenum and partly without it, though it seemed definitely to be arising from it. It was situated on the anterior wall and nearer the superior border, so that the extra-mural portion—the bigger—was within the hollow of the curve formed by the duodenum. There was no dilatation of the proximal duodenum, but there was some slight hypertrophy of its wall. The swelling with a cuff of duodenum round it was resected, and the hole in the duodenum sutured transversely so as to obviate narrowing of the gut.

The superior mesenteric artery was identified and held aside during the procedure. It was felt that the suture was not altogether safe, and to relieve any possible tension, a posterior gastro-enterostomy was performed. The peritoneum over the posterior abdominal wall was sutured, and the abdomen was closed without drainage.

POST-OPERATIVE COURSE.—The patient's pulse rose to between 120 and 130, her temperature being about 100° on the third day following the operation, the pulse rose still higher to 140, the temperature at the same time rising to 103·4°. She died on the following day, with a temperature of 105° and a pulse varying from 150 to 160.

AUTOPSY.—A limited examination through the incision was made after death. The abdominal cavity was normal, there had been no leaking, the sutures had held, and the anastomosis was sound. There was no distension of the stomach or bowel. Death was probably due to post-operative exacerbation of thyrotoxicosis.

Gissel,[22] in discussing thyrotoxicosis, mentioned two deaths, one following operation for carcinoma mammæ and the other a hernia, in patients suffering from thyrotoxicosis. He points out the importance in these cases of pre- and post-operative medication for the thyroid condition, similar to that given them prior to subtotal thyroidectomy. Both his cases had had pre-operative iodine, but in the one iodine had not been given after operation, and in the other it had been stopped owing to the onset of influenza. The patient here reported had pre-operative medication, but no post-operative iodine, except prior to death.

EXAMINATION OF SPECIMEN (*Fig.* 213).—This resembled in form a uterus, the part protruding within the duodenum being very like the vaginal cervix, the part outside like the fundus and body of the uterus, whilst the intervening portion was embraced by the duodenal wall. After fixation the dimensions of the tumour were approximately: 5·4 cm. in length, the upper end was 4·6 cm. × 3·2 cm. in area, whilst the intraduodenal part was

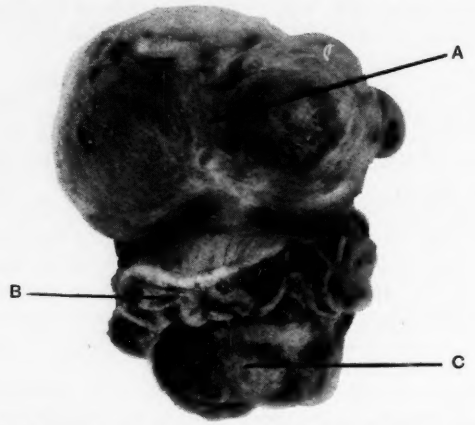

FIG. 213.—Macroscopic appearance of tumour. A, Extramural part; B, Duodenal cuff; C, Intraduodenal part.

2·2 cm. in its broader and 1·7 cm. in its narrower diameter. The length of tumour outside the wall was roughly 2·7 cm., the part within the lumen 2·3 cm., and the remaining 0·4 cm. was intramural.

The intraduodenal portion was smooth, not ulcerated, the free end having a depression in it about 0·2 cm. deep. The outer portion was smooth, but close to the wall of the duodenum, arising from the main mass, there was a small pedunculated tumour, rather flat, and very like a tiny subperitoneal fibroid. The tumour was fairly hard, and dull fleshy in colour.

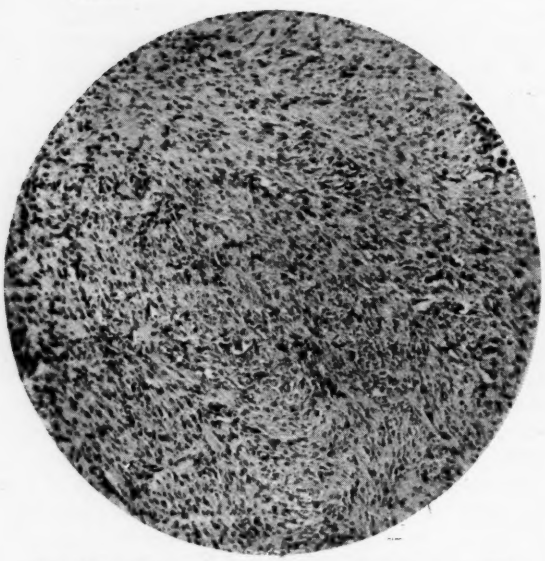

FIG. 214.—Microscopic appearance of tumour. (× 50)

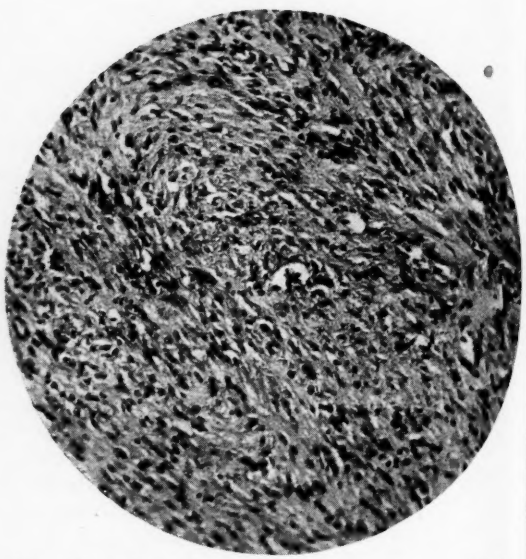

FIG. 215.—Microscopic appearance of tumour. (× 105.)

A microscopical examination of a piece taken from the 'fundus' was made by Professor J. Henry Dible, who reported: "This is a borderline growth of unstriped muscle—myosarcoma. I think it is the sort of case in which recurrence may be looked for." (*Figs.* 214, 215.)

DISCUSSION

Etiology.—

Age.—Libman, collecting 51 cases of sarcoma of the small intestine where the age was noted, found the distribution to be as follows: First decade, 6; second, 9; third, 13; fourth, 13; fifth, 8; sixth, 1; and seventh, 1.

Sex.—In the cases collected by Libman the condition was found to be two and a half times as common in men as in women.

The causation is unknown. A case has been described (Bland-Sutton[13]) in which the sarcoma, spindle-celled in type and situated in the first part of the duodenum, was associated with the scar of a healed duodenal ulcer. The association —in view of the frequency of duodenal ulcer and rarity of sarcoma—was almost certainly fortuitous.

Pathology.—All varieties of sarcoma have been described, mixed-celled sarcoma, lymphosarcoma, spindle-celled sarcoma, myosarcoma, endothelioma, malignant melanotic and round-celled sarcoma, though the latter perhaps should be classed with the lymphosarcoma. Secondaries occur especially in lymphosarcoma, possibly the commonest type found in the small intestine.

The tumour is usually primary in the duodenum, though secondary tumours are also described—for example, the case of lymphosarcoma arising in the retroperitoneal glands and secondarily involving the duodenum described by Moore,[23] and the case of spindle-celled sarcoma of the first part of the duodenum described by Laroque and Shiflett[21]—the primary being a fibrosarcoma of the thigh.

Symptoms and Clinical Course.—The length of history is usually short—two weeks to twenty-one months (Baltzer[24]). Rarely, however, the history is of longer duration—for example, in the case of myosarcoma of the duodenum reported by Von Salis, where the history was of seven years' duration.[15]

The symptoms are those of dyspepsia—perhaps the pain may be colicky. There is usually vomiting, loss of appetite, and loss of weight; occasionally there is a history of blood appearing in the vomit. The tumour may further give rise to symptoms because of: (1) Pressure on surrounding structures (*a*) the vena cava, causing œdema of the legs and ascites, (*b*) the bile-ducts and pancreatic duct (Lancereaux,[25] sarcoma of the duodenum), (*c*) the ureters; (2) Ulceration—which may lay open vessels—for example, Rolleston's[26] case of sarcoma of the duodenum (probably a lymphosarcoma) which eroded the inferior pancreatico-duodenal artery with consequent fatal hæmatemesis. Palpable tumours are uncommon. Where metastases occur, these are more likely to be a factor in the diagnosis. The characteristics of the tumour are those found in the case recorded.

The history is not suggestive, nor are the physical signs, and these cases were at one time diagnosed either at laparotomy or post-mortem. Latterly, however, diagnoses have been made based on radiological findings. Freud[14] thus was able to diagnose a sarcoma of the fourth part of the duodenum and upper part of the jejunum with metastatic deposits in the bowel. At operation multiple metastases were found on the bowel with infiltration of the walls of the terminal duodenum and some dilatation.

The tumour gives rise to a vacuolar filling defect, and if this is associated with dilatation of the duodenum proximal to it, a diagnosis of tumour of the duodenum

may be made. The defect is best shown with the patient in the right oblique position (Waters).[27]

The tumour in the case recorded was in the transverse part of the duodenum and unassociated with dilatation or stenosis, so that its demonstration by radiography must be very difficult.

Treatment.—This is surgical. The majority of tumours are situated in the first and second part of the duodenum, so that this may be excised and an end-to-end anastomosis with the stomach performed. In the third part a local excision is probably the best operation with a short-circuit to relieve tension from sutures placed in a viscus only partly peritonealized.

SUMMARY

1. A case of myosarcoma of the duodenum is reported.

2. The difficulties of diagnosis are noted.

3. The necessity for pre- and post-operative medication in cases of thyrotoxicosis, whatever the operation may be, is stressed.

It is a pleasure to express my thanks to Professor R. E. Kelly, under whose care the patient was and who performed the operation, for permission to publish this case. I am indebted to Dr. R. E. Roberts for permission to publish the radiological findings, and to Professor J. Henry Dible for the microscopical report on the tumour.

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THE ESTABLISHMENT OF A LARYNGEAL BY-PASS

By H. P. PICKERILL, C.B.E., Sydney

This note is the record of an attempt to avoid the disadvantages of a permanent tracheotomy tube, and at the same time conserve a sufficient airway without impairment of the voice.

The patient, a good-looking, petite girl, aged 25, had a partial thyroidectomy performed in January, 1930. This was followed by increasing dyspnœa for eighteen months, with an extremely weak but distinct voice. In August, 1931, a tracheotomy was done and the tube worn constantly until I saw her in December, 1932. Dr. Garnet Halloran (laryngologist) then reported: "Examination of the glottis reveals bilateral abductor paralysis. There is only the slightest movement of both cords on phonation or inspiration. The resultant glottic chink would not be sufficient without a tracheotomy tube."

Various laryngeal operations were discussed—decortication of the cords, and so on—all of which the patient declined on being told that they would undoubtedly affect her voice adversely. After considerable thought, therefore, and having explained the details to the patient, I determined to endeavour to establish a by-pass airway, as I concluded that anatomically, if not surgically, this was possible. The objective was to establish an additional airway which would pass external to the laryngeal cartilages but underneath the skin, from the tracheotomy opening in the trachea to a point in the larynx above the constricted vocal cords. I formed the opinion that three was a small area between the cushion of the epiglottis and the false vocal cords which might be utilized for the insertion of a tube, and at which point air would be free to pass on inspiration and expiration, but which would be closed on deglutition. I fully explained all these things to the patient, who, I must say, entered into the plan of campaign with considerable interest and understanding. "Anything," she said, "to get rid of this horrible hole in my neck, so that I can surf bathe and dance like other girls."

My plan was first of all to establish a skin-lined subcutaneous tube passing from the tracheotomy opening to an opening in the larynx made just at the notch in the upper border of the thyroid cartilage. I had a solid core of vulcanite made of correct size and shape, and then applied a Thiersch graft to it, and inserted it subcutaneously. Owing, however, to the smallness of the patient's neck and the comparative tightness of the skin, this could not be inserted satisfactorily and would not stay in place. I therefore fashioned a larger silver tube, made in two parts and connected in the middle by a sliding tube (*Fig.* 216). The lower half of the silver tube was inserted into the tracheotomy opening and turned so as to resemble, and function as, an ordinary tracheotomy tube (*Fig.* 217). An incision was then made over the upper part of the thyroid cartilage and thyro-hyoid space. The cartilage of the thyroid notch was then deepened a little. Next, with the direct laryngoscope held in place by the anæsthetist, I was enabled to pass a sharp-pointed

probe from the outside to the inside of the larynx at the exact spot at which I wished it to be—namely, just above the false vocal cords and below the cushion of the epiglottis. With the probe in position a bistoury was passed alongside it, and a vertical incision made through the thyro-hyoid membrane and mucous membrane of the larynx. This was dilated and the flange-like end of the upper silver tube insinuated into place and observed via the laryngoscope to be lying snugly in position. There was no trouble from any hæmorrhage into the larynx.

Whilst the patient was still under intratracheal anæsthesia, the by-pass was tested by joining the two ends with the sliding tube, and apparently it functioned well. In fact there was an obvious improvement in respiration. But would the patient be able to swallow without fluids entering the tube, and therefore the trachea? Here, of course, was the object of the two-part tube. The two portions

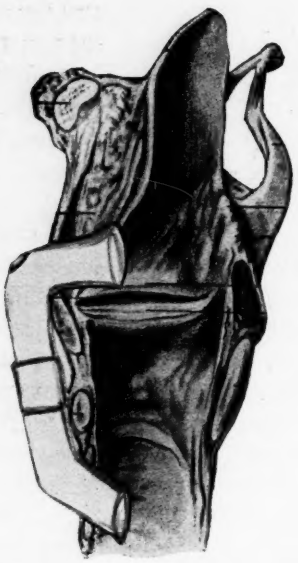

FIG. 216.—Semidiagrammatic view of larynx, with by-pass tube in position. The two parts of the tube united in the middle by a sleeve.

FIG. 217.—Semidiagrammatic view of the larynx, showing by-pass tube in two parts in position—the lower half turned to act as a tracheotomy tube, and the upper half left open for observation.

were left in position unconnected, but with the lower end turned to the tracheotomy position until the day after the operation, as shown in *Fig.* 217. The patient was then given a little water to drink and we were very gratified to find that none came through the lower end of the upper part of the tube. The two tubes were left thus for several days, until swelling and tenderness had subsided, and it was obvious that deglutition could take place without any danger of either fluid or food particles entering the upper end of the tube; and then the two tubes were connected in the middle by the sliding tube as in *Fig.* 216. From that point we progressed slowly, but with complete success, to normal feeding, and connecting up the two parts of the tube. We had demonstrated that a laryngeal by-pass was physiologically possible. Respiration was easy and comfortable, the voice definitely stronger, and deglutition normal.

The by-pass tube was during this time lying external to the skin, held in place

by strapping and tape. To cover the silver tube I fashioned a Thiersch-lined tube-graft from the chest, and swung the lower end up to a prepared bed under and around the exposed portion of the silver tube. Thus the tube was not visible, though the graft and the subjacent tube made a prominence on the neck something like an exaggerated 'Adam's apple'. All this occupied several months. When the patient was last seen, the apparatus was functioning excellently. Voice, respiration, and deglutition were normal. The patient could bathe, she danced again after three or four years, and she has been in the cold country amongst snow without any untoward effect. The only disadvantage was the difficulty in keeping the tube clean. It was found that a film of mucus collected and this had a disagreeable odour. To overcome this I exposed the upper bend of the tube, drilled a hole in it, and had a small silver screw stud fitted. This the patient removes and cleans the tube with pipe-cleaners dipped in hydrogen peroxide. The stud she covers with a piece of jewellery or a narrow silk scarf.

In the original scheme of things it was proposed to remove the silver tube later, and graft in cartilage rings to maintain patency, but this awaits the patient's decision. In the meantime it is of sufficient interest to record that a laryngeal by-pass is anatomically, physiologically, and surgically possible.

I may say that the success of this somewhat tedious series of operations was largely due to the excellent assistance and suggestions of Dr. C. M. Clarkson (assistant) and Dr. Campbell Lamrock (anæsthetist).

EXCISION OF THE ŒSOPHAGUS FOR CARCINOMA

By R. RUTHERFORD

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HAVING read of Mr. Grey Turner's successful case and studied his Bigelow Lecture[1] advocating the pull-through method which he had evolved, I was very much struck by the avenue of hope laid open in an almost hopeless disease. About this time a man of 52 years presented himself with a five months' history of difficulty in swallowing. An œsophagoscopy was performed and a growth seen high up in the thoracic œsophagus (*Fig.* 218). A piece of the growth was taken for biopsy and the

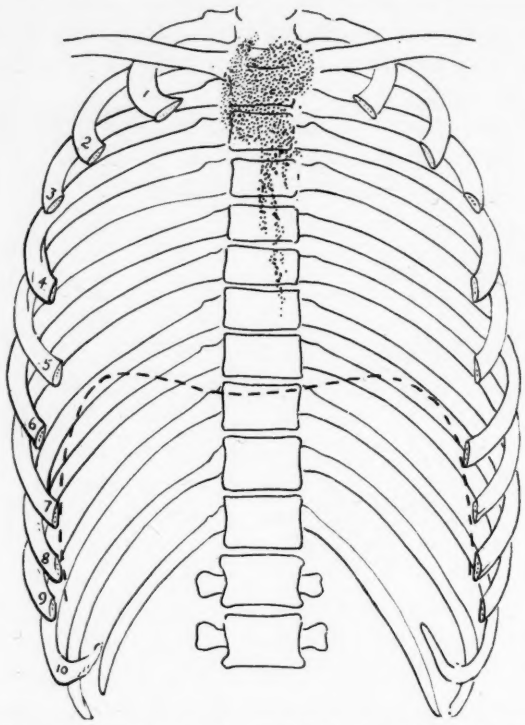

FIG. 218.—Drawing from a skiagram showing position of the growth.

diagnosis of carcinoma was confirmed. At the same time a laryngoscopic examination was done and the left vocal cord was seen to be immobile; gastrostomy was carried out the following day. The patient was in fairly good condition, weighing 8 stone on admission, and 8 stone 2 lb. three weeks later, when the œsophagectomy was performed following a blood transfusion.

OPERATION.—The intratracheal method of anæsthesia was adopted, giving gas, oxygen, and ether. The gastrostomy was excluded from the field of operation by a temporary collodion seal and the Grey Turner technique followed—i.e., a

vertical incision from the apex of the left costoxiphoid angle to the umbilicus, the mobilizing of the left lobe of the liver by cutting through the left lateral ligament by means of a pair of angled hysterectomy scissors and thus approaching the lower end of the œsophagus. It was found that by using the left hand as a retractor the left lobe of the liver was kept out of the way without withdrawing it from the abdomen, whilst the hand of an assistant kept the stomach out of the way on the opposite side. By this means a narrow lane was formed, at the end of which the terminal œsophagus could be plainly seen, and about 20 c.c. of 2 per cent novocain were injected beneath the peritoneum into the tissues surrounding the lower end of the œsophagus. A small transverse nick about $\frac{1}{4}$ in. long was made through the peritoneum covering the terminal œsophagus and the tip of the right index finger insinuated into the subperitoneal tissues and the enucleation commenced. It was not a difficult manœuvre, and I think perhaps the secret lies in working in the tissues deep to the nerve plexuses, and one had the sensation of working inside a string tube; as long as one kept inside the strings the separation was easy. It was estimated that the maximum height reached by the abdominal finger was the second intercostal space (anteriorly). The abdominal wound was protected by towels and the cervical œsophagus exposed by a transverse incision dividing the left sterno-cleido-mastoid muscle completely and the œsophagus identified and mobilized.

FIG. 219.—The œsophagus has been slit up on its ventral aspect and shows that part of the growth adherent to the trachea.

As the downward enucleation proceeded it was found that at about the level of the second dorsal vertebra there was a dense mass firmly adherent to the dorsal vertebra behind and to the trachea in front (*Fig.* 219). These were broken down by digital pressure as far down as possible, but not far enough to reach the upward dissection. At this stage the cervical œsophagus was divided and the cut ends were 'bipped'. By virtue of firm traction from below and enucleation from above, the œsophagus was pulled downwards, divided near the stomach, and the stump buried by means of a purse string. It was then noticed that the stomach was suspended by its vagus nerves and that the left lobe of the liver when released resumed its normal position; a finger was passed to the site of the peritoneal incision to estimate its size and it was difficult to find because of its smallness. The skin incisions were closed, taking care in the neck incision to suture the medial edge of the sterno-cleido-mastoid muscle to the prevertebral fascia. The cervical œsophagus was stitched in the medial corner of the incision.

SUBSEQUENT HISTORY.—The patient did not seem to be upset by the operation; he had a pulse-rate of 90 and there was very little bleeding. After the separation of the growth from the posterior aspect of the trachea it was noticed that he coughed up some blood-stained sputum. At no stage during the operation did his condition give rise to any anxiety.

The following day the sputum was rusty, but his condition was quite good. The next day he had difficulty in breathing, the temperature was raised, and he unfortunately died.

AUTOPSY.—At a post-mortem it was found that the trachea was infiltrated by growth and had been injured in separating the dense adhesions; no macroscopic breach in continuity of the tracheal mucous membrane could be detected, but the fact that he had blood-stained sputum coupled with the microscopic report on the trachea involved pointed the cause of the failure.

COMMENTARY

The points that are instructive in this case are: (1) The paralysis of the left vocal cord; (2) The involvement of the trachea. With regard to the first point, and in the light of the findings at operation, the left recurrent laryngeal nerve was manifestly involved, and by comparison with facial palsy complicating malignant parotid tumours, one may safely assume that this was an actual involvement by growth. Touching the second point, it is felt that the pre-operative investigations might have been rounded off by an endoscopic examination of the trachea and/or bronchi, and that any undue inflammation of the mucosa should preclude operative interference.

To sum up, it would seem that operation is not contra-indicated by a laryngeal palsy provided the surgeon is prepared to bury radon seeds in the infiltrating growth not removed; on the other hand the operation is contra-indicated when it can be established that involvement of the trachea or a bronchus is present.

The lessons learnt from the actual operation were: (1) The absence of shock to the patient; (2) The absence of severe hæmorrhage; (3) The tendency for the left lobe of the liver to resume its normal position without suspension to the diaphragm by suture; (4) That a small initial peritoneal incision relieves one of the necessity of stitching the liver over to prevent herniation and that it is possibly an advantage to have a lower outlet to the traumatized œsophageal tunnel; (5) Provided one enucleates inside the nerve plexuses and leaves the vagi intact there is a natural suspender for the cardiac end of the stomach.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD

THE ACCIDENT HOSPITAL OF DR. BÖHLER IN VIENNA

THE origin, structure, and organization of this hospital are all so unusual that it is necessary to devote a few introductory words to them before describing the incidents of a recent visit.

In modern days it is the fashion to make hospitals large, expensive, and showy; but Dr. Böhler has been quite independent of any great outlay of money. He saw and seized a unique opportunity of utilizing a building designed for another purpose, and during the last nine years he has formed a wonderful hospital organization, which, instead of costing money, has paid for itself and its staff and saved money for the community.

Dr. Böhler's experience of traumatic surgery, especially in the treatment of fractures, during the War, made him realize the terrible waste of lives, of limbs, and of working capacity that results from the neglect of prompt, efficient, and thorough treatment of wounds and other injuries. Therefore in 1919, when the end of the War left him free to turn his attention to peace problems, he offered his services to his own country, Austria, in order to save the victims of industrial accidents from mutilation, invalidity, and incapacity. In 1912 there had been built on the south bank of the Danube, in Vienna, a large building, six stories high, for the offices of the National Insurance Company. This was designed on a large scale, so as to be able to deal with the working population of the Austro-Hungarian Empire, which included 56,000,000 people. After the re-distribution of Central Europe this Company had only to insure the working people of Austria, with its population of 6,000,000. The building was therefore out of all proportion to the needs of the office. Dr. Böhler suggested that part of it should be converted into a hospital for the treatment of insured persons. His idea was accepted in principle, but just at that time the financial crisis caused by inflation was so severe that all new developments were suspended, and it was not until 1925 that the suggestion was carried out. (*Fig.* 220.)

The upper two floors of the insurance building were then adapted as a hospital, accommodating 120 in-patients, the operating- and treatment rooms, X-ray room, and offices, as well as affording residence for the nursing and surgical staff. The wards, thirty-two in number, are arranged on the outside of two sides of a square, whilst the kitchens and offices lie on the corresponding inner sides. The largest wards contain five beds, the smallest three, and, although lofty and well ventilated, are rather overcrowded as compared with our modern hospital standards, but not so much crowded as is usual in continental hospitals, such as the General Hospital in Vienna.

The visitor approaches the hospital, then, through the entrance of the insurance company's offices. As he takes the lift to the fourth floor, or climbs the one hundred stairs, he realizes that the hospital is only a department of the insurance business. On the landing of the fourth floor there are two doors, one leading into the hospital and the other into Dr. Böhler's private residence. The main examination and treatment rooms are six in number, arranged in a series opening into one another, or rather communicating with a common passage. An office where records are stored and X-rays are examined, and the X-ray room, with couches for two patients, are at one end of this series. The X-ray plant, which includes

FIG. 220.—The 'Unfallkrankenhaus'.

a very efficient portable machine, is remarkable for its simplicity. Every year between 12,000 and 13,000 pictures are taken, the majority by one of the nursing sisters, the others by one of the assistant surgeons. Both the X-ray apparatus and the films themselves are available for use or reference at any time by day or night. Next to the X-ray room is a receiving-room where minor surgery is done and where the examinations and preliminary treatment of all new out-patient cases are carried out. This can be divided by curtains into several parts, so that three or four cases are usually being dealt with at the same time. Then come two operating-rooms, separated from one another by a room for instruments, dressings, and sterilization.

The surgical staff (*Fig.* 221) consists of Dr. Böhler, two chief assistants, four secondary assistants, and two junior assistant surgeons. One of the chief assistants lives outside the hospital and is allowed to do private practice; the others are residents and give all their time to the hospital. The whole surgical staff are at work every week-day from 7.30 a.m. to 2 p.m., and for the rest of the twenty-four hours and on Sundays there are always four surgeons on duty, day and night. The first assistant has been with Dr. Böhler since the opening of the institute nine years ago, the others for two or three years, thus affording an eloquent testimony to the enthusiasm which he inspires.

The nursing staff is twenty-four in number, including a matron and six sisters. They have been trained in one of the training schools of Vienna.

On entering the treatment department one is at first confused by the many things which are going on at the same time—an almost bewildering activity—two

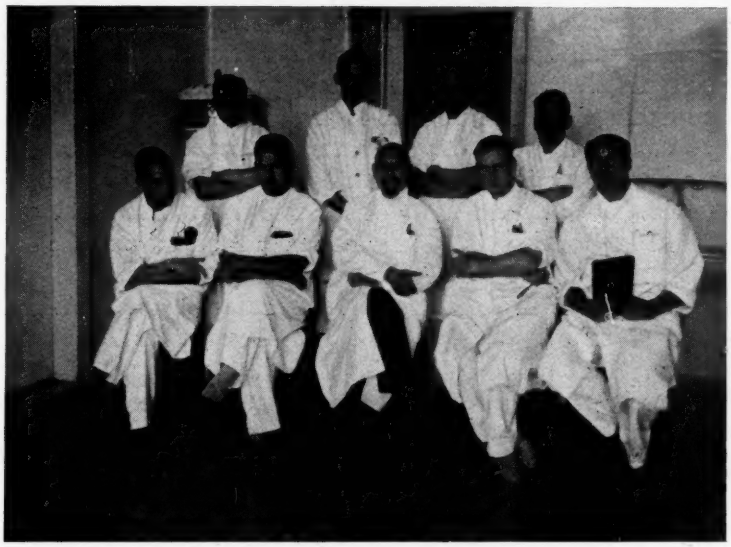


FIG. 221.—Dr. Böhler and his assistants.

sets of X-rays being taken, others being developed and inspected, a recent case having the wound excised, a fractured arm or leg being reduced under local anæsthesia and put up with pin or wire traction and the application of plaster; a major operation such as the pegging of the neck of a femur in one theatre, and the setting of a fractured tibia by screw traction, transfixation, and plaster in the other. But it soon becomes apparent that this manifold activity is not confusion, but merely the organized activity of the beehive where every unit has his appointed task, which he does without interfering with the others.

Over two-thirds of the patients are working people, insured against accidents. The remainder consist of private patients, six to twelve in number, and those cases of accident too urgent for inquiry to be made before admission. The private patients pay 20 to 25 shillings* a day, and the others 8 to 11 shillings. All insured

* The shilling referred to in this article is the Austrian schilling of which 27 go to £1 sterling.

persons have a right of admission to this hospital, but there is no compulsion. In 1932 there were 1916 in-patients, with an average stay in hospital of seventeen days, and 6478 out-patients, with an average period of fifteen days. The total cost of treatment during this year (1932) was £15,300, and it is estimated, by a careful comparison with the same number of cases treated elsewhere in unorganized clinics, that a sum of money is saved which is just double the cost of treatment. This is no rough-and-ready estimate but is very amply borne out by a great wealth of statistical information. It is thus made perfectly clear that this hospital organization is a sound business proposition, not dependent on sentiment, charity, or mendicancy.

The major operations are done three days a week, from 7.30 to 10.30, after which Dr. Böhler does a round of the wards accompanied by all the assistants who are not engaged in the receiving-room, a sister and nurses responsible for each ward, and visitors. On each round about forty cases are seen and examined in detail, the rest cursorily. Every patient is examined and a note taken once a week. An X-ray-viewing apparatus is available in every ward, and the X-rays are seen of all new patients and those patients examined in detail at the weekly visit.

But the examination and report of the X-rays is much more formal than this. On the three mornings a week on which there are no major operations, at 9 o'clock Dr. Böhler and all his assistants sit down to a meticulous examination and report of all the X-rays taken during the past few days. The frontal and lateral films are put up in the viewing-box, the history of the case is given in brief, and one of the assistants is invited to describe it. A discussion of the nature of the injury follows, and then Dr. Böhler dictates his own notes and decides on the treatment or modification of treatment which is to be adopted. He is now engaged in an intensive study of fracture-dislocations of the cervical spine, and when the films of a new case of this injury were presented, antero-posterior, lateral, and oblique, they were examined in very great detail; the case proved to be a rotatory dislocation on the left side, between the 3rd and 4th vertebræ, with the fracture of the tip of the 4th articular process. The articulated vertebræ from a skeleton were at hand, and the exact displacement was demonstrated by their aid. The trivial fractures and dislocations of the bones of the wrist, fingers, and toes were all noted and described with equal care.

It will make for simplicity if we first describe the operations we saw and then some of the patients in the ward, to illustrate the chief points in Böhler's principles and practice.

OPERATIONS WITNESSED

1. **Open Fracture of Finger.**—This was one of the little finger in a man of 69. The finger had been torn on the dorsal surface, from above the knuckle to below the first interphalangeal joint. Local anæsthesia was used; the skin was not washed but painted with iodine; the torn skin edges were excised, leaving a considerable open wound. The proximal phalanx had a T fracture into the joint. The defect of the skin was made good by a free skin-graft from the thigh. The finger was fixed on a suitable bent-wire padded splint and the whole arm was elevated on an aeroplane splint, the patient being admitted to the ward. He had been advised to have the finger amputated, but he begged that it might be saved. We saw him several days later in the ward, too soon to say whether

the skin-graft would survive. (We have heard subsequently that the skin-flap did survive.) The great care taken over this comparatively trivial injury was very impressive, and we found it characteristic of the whole work.

2. **Open Operation for Ununited Fracture of the Radius.**—A man of 30 with fracture of the radius and ulna (November, 1933). The ulna had united but the radius presented a pseudarthrosis. It had been treated by double transfixion (olecranon and metacarpals), traction, and plaster-of-Paris. Later both ends of the bone had been subjected to multiple subcutaneous drilling by a wire drill 0·5 mm. in diameter. It was intended to do this operation under brachial plexus anæsthesia, but for some reason it was impossible to locate the brachial plexus with the needle, and anæsthesia was by open ether. Through an incision about six inches long the radius was exposed at the site of fracture. The pronator teres lay obliquely between the fragments and had obviously been responsible for non-union. The interposing muscle was cut away, and both bone-ends were cleared

FIG. 222.—Excision of wound of the finger under plexus anæsthesia.

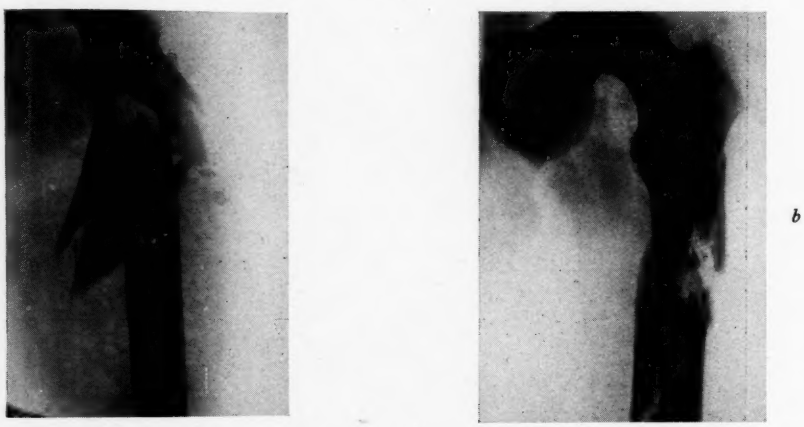
of scar tissue and refreshed by a nibbling forceps, until the marrow cavity was exposed in each. The oblique fracture could then be held in good position by Lambotte's forceps. The fragments were united by a single strand of stainless iron wire, which perforated and surrounded the bone. All the scraps of bone which had been removed were packed round the area of fracture. The wound was closed by three layers of interrupted sutures. The patient was removed to the adjoining room and the arm put up in an unpadded plaster cast, extending from the shoulder to the knuckles, the elbow at a right angle and the forearm midway between pronation and supination. The whole limb was finally placed on an aeroplane splint.

3. **Removal of Chondroma from the Knee-joint.**—A man of middle age who had had intermittent pain and disability in the left knee. A tentative diagnosis of loose body in the joint had been made, the X-rays being negative. Under spinal

anæsthesia the knee was opened by a longitudinal incision, medial to the patella. A fibro-cartilaginous mass was found growing from or attached to the deep surface of the vastus medialis; it was removed. The knee was closed by two layers of interrupted silk suture.

4. **Dislocation of the Shoulder.**—A stout woman of 55, who had had an accident three weeks previously; she had been treated elsewhere, but on account of the great swelling of the shoulder the nature of the injury had not been recognized. There was an anterior dislocation of the shoulder, the great tuberosity being fractured but not separated. Under general anæsthesia by ethyl chloride the shoulder was reduced by steady manual traction, counter-traction being made by the heel in the axilla. After reduction was effected, the arm could easily be put in and out of its socket. It was bandaged to the side. X-rays showed reduction to be satisfactory. In a week's time it would be put up on an aeroplane splint.

5. **Old Fracture of the Neck of the Femur.**—Johansen's modification of Smith-Peterson's method. A healthy man of 50 had had a fracture of the neck of the femur in February, 1934, and had been treated elsewhere by pin



a *b*

FIG. 223.—Case of gunshot fractures of the femur occurring in the rioting in February, 1934. *a*, On admission; *b*, Three months later.

traction and plaster casts. He presented a typical medial fracture of the femoral neck, with shortening and varus deformity. Three days previously a pin had been put through the tibial crest and weight traction applied. X-rays showed the reduction was incomplete. Operation took place under spinal anæsthesia on June 8, 1934. Powerful traction was made by a screw traction apparatus. X-rays taken by a portable apparatus showed reduction to be satisfactory. Three small pieces of metal were stuck on to the skin along the line of the neck of the femur for purposes of orientation. Two long boring wires were then thrust about 11 cm. from the base of the great trochanter upwards and inwards to the head of the femur. X-rays showed that neither wire was in a satisfactory position, one having slipped in front and the other behind the head of the bone. This procedure had to be twice repeated before the pin could be placed in position satisfactorily. The flanged Johansen pin was inserted through an incision about four inches long, the central hole in the pin being passed over the right wire guide and driven home. The last set of X-rays taken while the patient was on the table (actually the sixth

in point of number) showed the final position to be satisfactory. The spinal anæsthetic did not last long enough, and a little general anæsthetic by open ether was given from time to time at critical stages of the operation, the patient himself begging that he should not be rendered unconscious.

The circumstances of this operation were noteworthy. In spite of the utmost care in the matter of orientation the wires seemed obstinately to refuse to go where they were wanted, and yet everything was done with calm deliberation and utmost precision, without hurry or flurry. It was difficult and disappointing for an operator, who would naturally have liked everything to go quickly and smoothly. There was, however, no sign of irritation either by word or gesture, nor was there the slightest suggestion of abandoning the attempt until success had been achieved. We saw a number of other cases in which this operation had been done with complete success at varying periods after the accident. On return to his bed the patient's leg was elevated on a Braun's splint, with adhesive plaster traction and suspension of the toes. This was to be maintained for a week, when a plaster cast would be applied and fourteen days after the operation he would be allowed to walk.

THE TREATMENT OF CERTAIN TYPES OF CASE SEEN IN THE RECEIVING-ROOM AND ON THE WARD ROUND

The Setting and Fixing of Recent Closed Fractures.—Each case is immediately X-rayed and anæsthetized by local infiltration, brachial plexus, or spinal anæsthesia. In fractures near the joints with no apparent displacement, an attempt

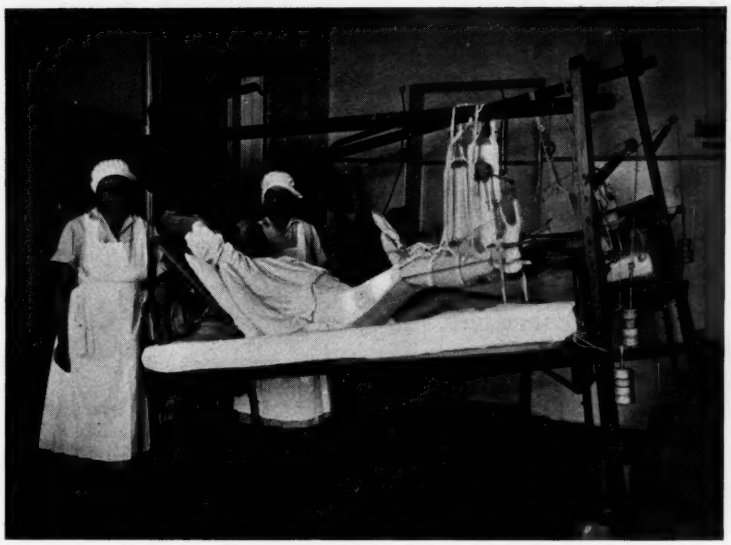


FIG. 224.—Fracture of femur treated by elevation and traction.

is made to produce displacement and X-ray examination is repeated. In this way a good idea is obtained of the liability to displacement. The fracture is then reduced, fixed by manipulation and skeletal traction, and again X-rayed. When satisfactory it is fixed in an unpadded plaster cast, the skeletal traction usually

remaining. The limb is always put up in an elevated position—the leg on a Braun's splint, the arm on an aeroplane splint (*Figs.* 224, 225). The next day, and then daily afterwards, all joints of the limb not fixed by plaster are moved by active contraction of the muscles. In closed fractures of the leg below the knee a few days after the setting a walking-iron is incorporated in the cast, and the patient gets up daily. No crutches of the ordinary kind are allowed, but in the first days of walking four-legged hand crutches are used until the patient can support himself with sticks. Patients with fractured femurs begin to walk in casts with walking-irons from six to eight weeks after injury. In all cases of lower-limb fractures, when the plaster cast is removed an Unna's paste dressing is applied from the toes to the knee, and in this way œdema is prevented. We actually saw a great number (over 100) cases of closed fractures of the lower limb, without ever seeing any swelling or œdema round the ankle. No case of fracture had any stiff joints apart from those where the joint itself had been involved.

FIG. 225.—Fracture of humerus. Traction on an aeroplane splint.

The formula for the treatment of recent closed fracture is, then: (1) Accurate setting and X-ray control; (2) Uninterrupted fixation until bony union is firm; (3) Elevation of the injured limb; (4) Active exercise of the muscles and proximate joints; (5) Natural use of the limb as soon as union allows.

Wounds and Open Fractures (*Figs.* 226, 227).—Wounds of the skin and soft parts receive the same treatment whether there is an associated fracture or not. There is no washing of the limb or even of the skin round the wound. Exuberant hair is cut away by scissors or dry shaving, and the parts are freely painted with iodine. Local anæsthesia is employed, either infiltration round the wound, or of the regional nerves. Brachial plexus or spinal anæsthesia is used for the more severe type of case. The edges of the skin and damaged surface of the soft parts are excised.

The cleansing is mechanical, not by chemicals or washing. This mechanical cleaning by the careful excision of damaged tissues requires great time and patience. The patient illustrated in *Fig.* 228 had a machinery accident in which his arm was caught in a revolving belt. The wound toilet in this case occupied close upon three hours, and a general anæsthetic was necessary before its completion. The patient who had had this injury was seen by us a year later, with a very useful arm.

If the bone is fractured, all fragments of any size are preserved and dirty surfaces are cleaned by nibbling forceps, not by mere scraping with a spoon. No fixation or suture of the bone is permitted; in fact no ligatures or sutures of any kind are buried in the wound unless this should be necessitated by the injury of

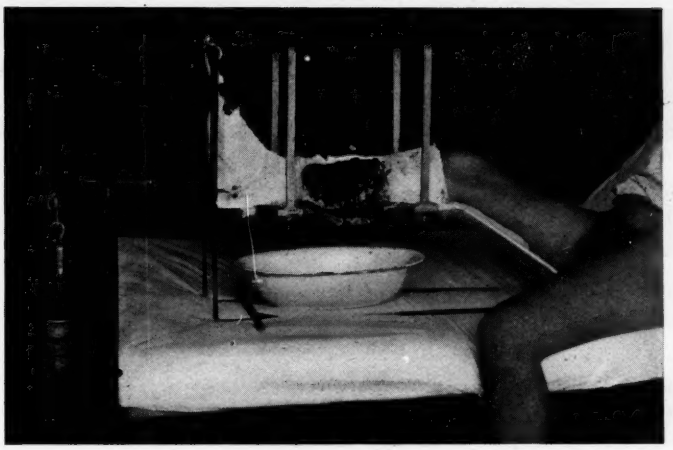
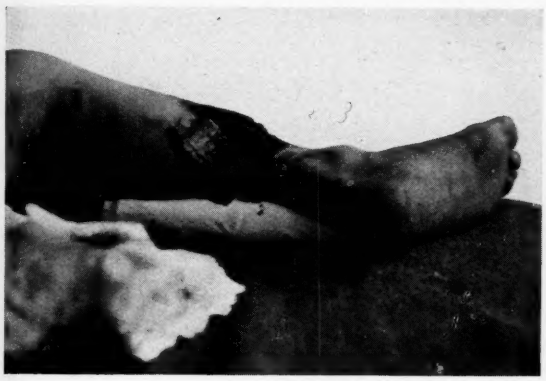
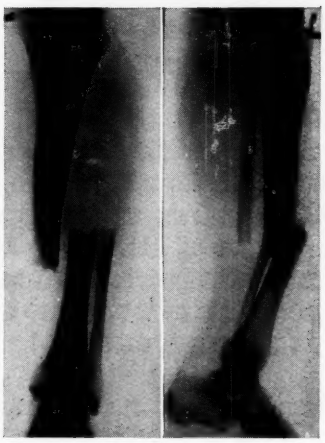


FIG. 226.—Open fracture wound treated without any dressing.



a

b

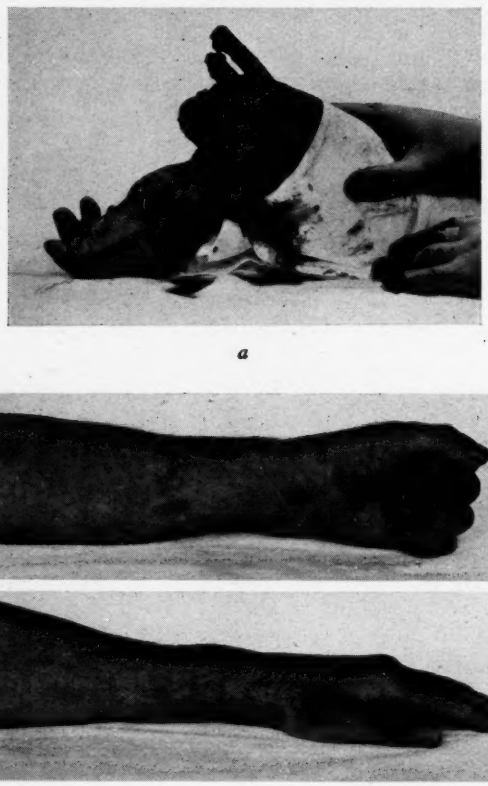


c

d

FIG. 227.—Open fracture of tibia and fibula resulting from a run-over by a heavy lorry. *a*, *b*, *c*, Condition on admission; *d*, X-ray taken four months later when the patient was able to return to work.

a considerable blood-vessel or the division of a nerve-trunk. The skin is sutured if this can be done with not more than moderate tension. The fractured limb having been put up in the usual way (traction, plaster-of-Paris), the sutured wound is left quite uncovered and exposed to the air. Contamination by dust or flies is avoided by the use of a single layer of muslin arranged as a cage over, but not in contact with, the limb. If the wound heals by first intention, the silk stitches are left in place for one to six weeks. If the wound breaks down, or if there has been



a

b

FIG. 228.—Open fracture of radius and ulna resulting from a machinery accident. *a*, Condition on admission; wound toilet took nearly three hours. *b*, A year later—condition when we saw the patient —almost perfect function.

a skin defect from the first, this is allowed to heal under a scab. We saw upwards of fifty cases of wounds, most of them associated with open fractures, and in not one was there any evidence of spreading infection, either local or constitutional.

Dr. Böhler lays no claim to originality in the matter of not washing wounds, of using no dressings, or of applying plaster casts without padding. In regard to the last two points, at first he was forced by the necessities of the War to dispense with either dressings or padding, and having used these simple methods, he became convinced of their superiority.

Fractures of the Spine (*Fig.* 229).—These form a very important and interesting group of cases. After exact frontal, lateral, and sometimes oblique X-rays have been taken, the patient is kept at rest for a few days before reduction unless there is paralysis, in which case reduction is done at once. Local

(paravertebral) anæsthesia is given by injecting 5 per cent novocain by the side of the affected vertebral bodies. The reduction is made by hyperextension of the spine, the head and arms resting on a high table and the legs on one much lower. The rectification is checked by fresh X-rays, and if necessary the hyperextension is increased. The posterior prominence (gibbus) disappears as rectification is effected. The bony points of the pelvis are protected by wool stuck on by mastisol, the trunk is enveloped in a piece of stockingette, and the plaster case applied. Within three days to a week the patient is allowed up, and it is almost incredible how quickly he is able to carry out the exercises prescribed for him. At first these are only active movements of the arms and legs, but at a later period weights are carried on the head, beginning with 5 kilos and increasing to 40 kilos, whilst trapeze gymnastics are finally performed. (*Fig.* 230.)

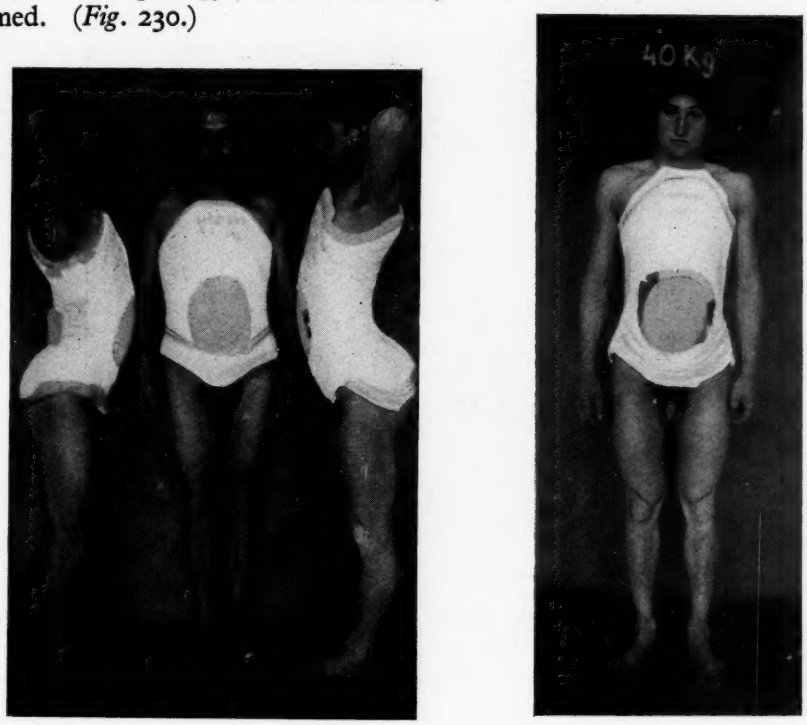


FIG. 229.—Group of cases of compression fracture of spine in plaster. Note the hyperextension (lordosis).

There were actually five cases of compression fractures or fracture-dislocations of the spine as in-patients on the occasion of our visit. One, a case of fracture-dislocation of the cervical spine, was awaiting reduction, three cases were still in plaster, and one had had his plaster removed. All were men, and they occupied one ward. This principle of putting similar cases together was always carried out as far as possible. Each group seemed to form a happy family, or school class, the 'old boys' encouraging the 'freshmen'. All are desperately keen to do their lessons well, and the repetition of the exercises, individually and as a class, before the visiting surgeons, at least once a week, is an event which they evidently enjoy. Dr. Böhler says that the treatment of injuries, and especially of fractures of the spine, is one part physical and three parts psychical.

The same spirit of happy enjoyment pervades the whole hospital, and among the 120 in-patients we saw only one or two depressed or unhappy, these being women recently admitted with head injuries. There were three cases of pulmonary infarct from embolism, all in stout middle-aged patients with fractures. This complication had occurred in all three patients within twenty-four hours, and we were told that this is their usual experience—namely, that a year or more will pass without a single case and then several cases will occur at the same time. It was suggested that meteorological conditions may account for this. Although accidents of all kinds are admitted, those involving thoracic and abdominal viscera constitute only about 2 per cent, and we saw only one case of appendicitis, one hernia, and one abdominal wound.

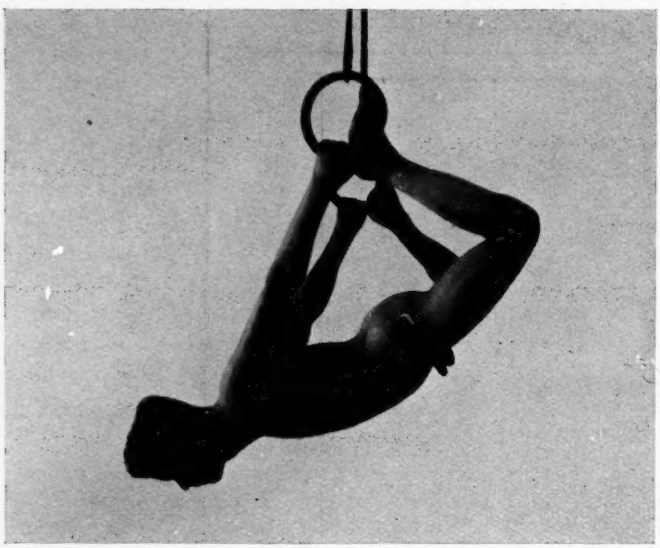


FIG. 230.—Exercises by man three months after compression fracture of spine.

All patients who have been discharged from the hospital and have not yet returned to work are seen by Dr. Böhler himself once a week, this inspection taking place on the ground floor of the large building. Every case is followed up until the final result is achieved.

The physiotherapeutical department is conspicuous by its absence. Except for some gymnastic appliances and those necessary for Swedish drill there is nothing of this sort. Massage and passive movement are forbidden in all recent injuries, and if proper treatment has been carried out, they are unnecessary at later stages.

The most prejudiced or sceptical observer cannot fail to be impressed by a visit to Dr. Böhler. In matters of technical detail there must always be room for differences of opinion. Particularly in regard to the treatment of recent fracture cases by operative methods, it would seem to us that Böhler has an aversion that almost amounts to superstition. Also in cases of pseudarthrosis the modern bone-grafting operation might find a much larger place. But the broad principles of the work: meticulous care in observation, treatment, and records; unremitting hard work in carrying out the treatment; enthusiasm for ideals, originated by the Chief, loyally followed by the team, and happily accepted by the patients; and, most convincing of all, the acid test of results—these all defy criticism.

EXPERIMENTAL SURGERY

THE SECRETION OF MUCUS BY THE EPITHELIAL CELLS OF THE GALL-BLADDER, AND THE EXPERIMENTAL PRODUCTION OF MUCOCELE

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THE descriptions of the epithelium of the gall-bladder given in standard text-books of histology are woefully scanty, in nearly all instances slightly inaccurate, and sometimes notably untrue. For instance, Maximow (1933) states definitely that the gall-bladder does not secrete mucus; Mann (1928), Jordan (1927), and Cajal (1933) make no mention of mucus granules in the cells; the tenth edition of Schafer (1916) contains a drawing taken from Sommer (1909) showing the granules, but does not mention them in the text, a later (twelfth) edition leaves out even this picture. A very good description is given by Pfuhl (1932) in von Möllendorf's expensive text-book, but even this account contains several minor inaccuracies.

MATERIAL

I have examined the gall-bladders from a large number of cats, and from several rabbits, guinea-pigs, goats, sheep, pigs, and dogs. At the beginning a number of different fixatives was tried out, and as a result of these experiences Helly's fluid was used as a routine.

Normal human material is very difficult to obtain. I have examined gall-bladders removed at post-mortem as early as one hour after death, but in every case the mucosa was largely degenerated. This rapid degeneration after death is well recognized; Boyd (1922–3) gives some evidence that it is produced by the bile, since gall-bladders kept in water did not degenerate as rapidly as those kept in bile. By the kindness of Dr. Carleton, of the Histology Department at Oxford, I obtained a number of sections of a normal human gall-bladder removed at operation. Further, it seemed to me probable that most surgeons remove a normal gall-bladder occasionally—a few operators even admit this—and I therefore arranged to have a portion of every gall-bladder removed over a certain period in the Sheffield hospitals fixed in Helly's fluid immediately after removal from the patient and long before it would normally be placed in fixative. This has proved a useful method. Of fifty such gall-bladders two appear to be normal histologically as they did macroscopically, and the clinical history does not seem to demand a diagnosis of any lesion in the organ. I do not suggest that this is necessarily a true proportion for all operations; it is possible that the surgeons were influenced to some small extent by the knowledge that I desired to collect normal material.

The other cases in this series provide well-fixed examples of inflammatory changes of varying kinds and degrees. Besides these I have examined a large number of gall-bladders sent in for routine examination. These were usually fixed in 10 per cent formalin, a bad fixative since it causes swelling and bursting of mucin granules. Furthermore, the material is seldom put into the fixative until some time after removal, so that it is very unusual in such specimens to find an intact mucosa. From the point of view of the epithelium such material is useful only in studying the incidence of such structures as 'Luschka's ducts' and metaplastic gland formation.

MUCUS SECRETION

The mucosa of the gall-bladder is covered by a single layer of tall cylindrical or prismatic cells, having a distinct resemblance to the intestinal epithelium from which they are derived during development. There is no essential difference between the mucosa of the gall-bladders of men, cats, dogs, goats, sheep, and pigs (*Fig.* 231). The epithelial cells of the rabbit's mucosa are, however, distinctive, in a manner similar to their intestinal epithelial cells (*Fig.* 232). The cells are more darkly staining, much narrower, have their nuclei closer to the free border, and do not normally show mucin granules.

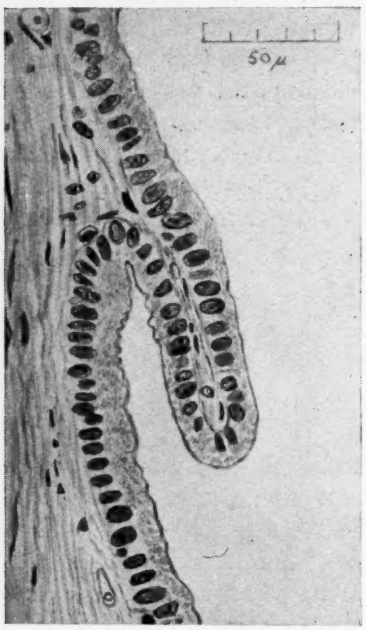

FIG. 231.—Normal cat mucosa. Fixed Helly's fluid. Stained hæmatoxylin and eosin. Drawn as seen under ⅛ in. objective.

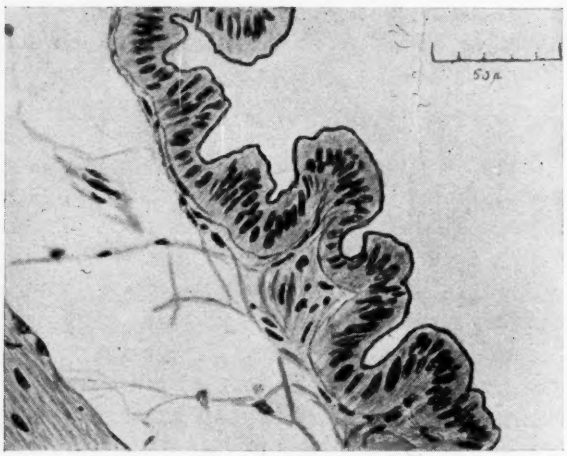

FIG. 232.—Normal rabbit mucosa. Similar fixation, staining, and magnification as *Fig.* 231.

In preparations fixed in Helly's fluid definite clearly outlined granules can be stained in the cells with mucicarmine. Many other fixatives, and in particular 10 per cent formol-saline, cause the granules to swell so that only a diffuse staining is to be obtained. Many writers—e.g., Pfuhl (1932) and Winkenwerder (1930)—state that a distinct red staining is not obtained with mucicarmine but only a pink coloration. I find that with good fixation and carefully prepared mucicarmine bright red staining of the granules is to be seen regularly in all my material except in the rabbit, for whose tissues Helly's fluid is possibly not a good fixative. More

consistent results are to be obtained with mucicarmine made according to Southgate's modification (1927), but the original Mayer's formula has worked well on occasions. In making the stain it is essential to follow the times given very closely; i.e., boiling must be for two minutes by the stop-watch. Metanil yellow used as a counterstain after hæmatoxylin and mucicarmine gives prettier pictures with the low powers of the microscope but tends to diminish the definition at high magnification.

The granules appear in that region immediately above the nucleus occupied by the Golgi body. From here they extend towards the free surface of the cell, sometimes in rows, and generally spreading out slightly fanwise so as to be closer to the lateral border at the summit of the cell. Granules are never seen below the level of the top of the nucleus in normal material, nor are they found reaching quite to the lateral borders of the cell. At the free border of the cell this mucus secretion can sometimes be stained passing through the pores or canals of the cuticle; more frequently tiny globules of secretion are visible sitting on the border after emerging from the cell.

In occasional cells containing only a relatively small amount of mucus, granules are found immediately above the nucleus only, or with also a few granules near the free border but at a distance from the supranuclear group (*Fig.* 233). This appearance suggests that the granules may be formed in relation to the Golgi body as described by Florey (1932) in mammalian goblet cells.

It is interesting to note that Erdmann (1931) found granules staining with mucicarmine in her tissue-cultures of gall-bladder epithelium. The granules were not very numerous, and the cells contained about the same number whether they came from a ten days' or a fifty-six days' culture.

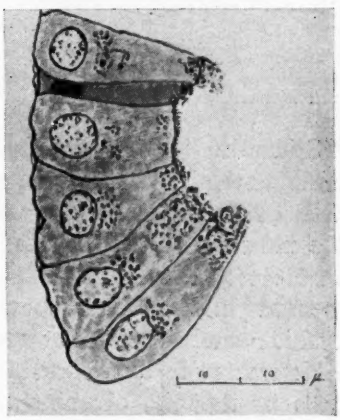

FIG. 233.—Normal human epithelial cells. Fixed Helly's fluid. Stained hæmatoxylin, mucicarmine, and metanil yellow. Drawn as seen through oil-immersion lens. Shows mucin granules in region of Golgi bodies and near free surface of cells; also striated border appearing as row of short hairs. The second cell from the top is a "Stiftzell".

As is to be expected, not all the cells are to be found at the same functional phase in any given organ. Some are filled with secretion, others are practically emptied; and all stages in the formation and discharge of this secretion are to be found. Such variation is not so much in definite areas of the surface as diffusely scattered. Thus a cell so grossly swollen with mucus granules as to bear some resemblance to a goblet cell may be flanked on either side by thin cells almost devoid of granules. Only a small proportion of cells in a normal gall-bladder, however, vary greatly from the average appearance described above. Cells containing large quantities of mucus may be mistaken for goblet cells on superficial examination, and their nuclei tend to be pushed closer to the base of the cell and to be flattened like an orange. The occurrence of such cells in small groups in the gall-bladder of a dog led Cutore (1906) to describe them as a peculiar form of intra-epithelial gland formation. In a later vigorous article (1910) he accused Jurisch (1909) of publishing similar illustrations without acknowledgement and with a misinterpretation of their significance. Jurisch's reply (1910) is simple and effective: "each cell of the epithelium can secrete and does so to a variable extent

according to its position—it does not advance our understanding of the secretory process to give special names to those cells which at the moment of fixation are secreting strongly."

Rather more common than the very swollen cells are others of a thin rod-shaped or whip-like form described at length as "Stiftzellen" by many writers. They are mentioned by Sudler (1901) and Aschoff (1905), whilst Shikinami (1908) found them in his material in varying numbers. Jurisch (1909) described them as very long thin cells having a darkly staining cytoplasm and with streak-like nuclei that might be indented or cornered. Both of the latter writers take the view that the secretion is formed in the ordinary epithelial cells, which with increasing fullness change into true goblet cells; the secretion then bursts through the cuticle and the emptied cell becomes a "Stiftzell". While Shikinami believed that the "Stiftzellen" were then freed and thrown off, Jurisch thought they could recover and that the functional cycle could start again. Winkenwerder (1930) described these cells and their staining characteristics, and traced the stages of their formation by the extrusion of mucus granules from the more usual epithelial cells. He found also that these cells exhibited a greatly augmented permeability for potassium ferrocyanide and ferric ammonium citrate. Although it is quite possible that these cells at the end of the secretory phase have a greater capacity for absorption than those actively forming secretion, his experiments are by no means conclusive since the chemicals used are definitely toxic. These "Stiftzellen" are to be found in varying numbers in all my material, occurring usually singly but occasionally in groups of three or four. Only a few of them are, however, completely devoid of granules; most of them show a few granules towards the free surface (*see Fig.* 233). I believe that they do not represent a different type of epithelial cell, but only a particular functional phase.

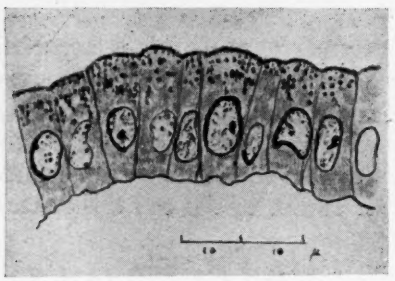

FIG. 234.—Normal cat epithelium. Similar fixation, staining, and magnification to *Fig.* 233. Shows mucin granules and striated border.

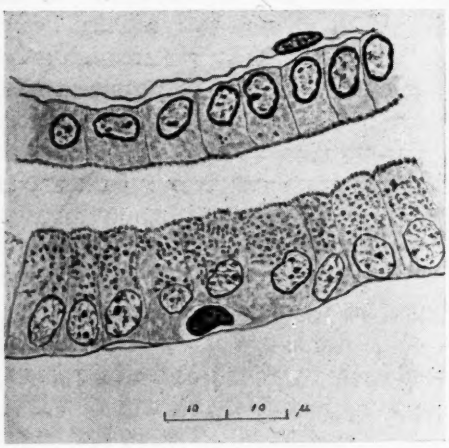

FIG. 235.—Normal cat epithelium. Similar fixation, staining and magnification to *Fig.* 233. Variation in mucin content in different areas. The two portions of epithelium illustrated become continuous further to the right in the actual specimen. (*Note.*—I have been unable to draw cells containing more than a moderate number of granules. Many cells contain a far greater number than those figured here.)

I have performed some experiments to demonstrate the actual secretion of mucus by the epithelial cells of cats (*Figs.* 234, 235). Under ether anæsthesia a small portion of the gall-bladder wall was removed and fixed immediately in Helly's fluid to serve as a control since the amount of mucus present varies from animal to animal. The opening in the bladder was sewn up and a solution of mustard-oil in olive-oil

introduced into the organ; after this the abdomen was closed and intravenous chloralose given. At the end of two hours the cat was killed, the gall-bladder removed immediately and portions of it fixed. It was found, as might be expected, that the epithelium was a very fragile structure and that mustard-oil solutions of a strength innocuous to the stomach or intestine produced marked damage. Weaker solutions (2 drops in 25 c.c.) produced no evident naked-eye or microscopical damage, but a very definite evacuation of the mucus granules was found in sections. It would appear, then, that the epithelial cells can be provoked to secrete by a mild experimental irritation. It is improbable that mustard-oil has any specific action beyond its irritative properties, and it seems likely that the operative procedures played some part in the production of the phenomena. Nevertheless, similar experiments using plain olive-oil did not give any marked evacuation of mucus. Evacuation of mucus has also been produced in cats by intravenous injections of pilocarpine in large quantities ($\frac{1}{2}$ c.c. of 1–1000 solution every fifteen minutes for two to three hours).

In naturally occurring inflammations in the human gall-bladder the mucus content of the epithelial cells varies considerably. Occasionally a mild acute inflammation results in the cells containing a greater amount of secretion than normal, and more mucus is found lying on the free surface. This is a condition of "catarrhal cholecystitis", and is only rarely seen in histological preparations. More frequently acute inflammation produces a destruction of a large number of the epithelial cells, especially the more superficial ones; ulcers are thus produced, and there is an accompanying acute inflammatory exudate of sero-fibrinous fluid and polymorphonuclear leucocytes. The remaining epithelial cells in these cases of "ulcerative or purulent cholecystitis" usually contain only a few granules of mucin. In chronic or recurrent inflammations of the gall-bladder the main features of the epithelial layers are the occurrence of hyperplasia with prolongations into the wall of the organ, and of metaplasia. Generally the amount of mucus secretion is increased, but there is considerable variation from case to case, and frequently in different areas in the same case. In the condition described as 'mucocele' or 'hydrops' of the gall-bladder, I have usually found marked flattening of the epithelial cells which contain only traces of secretion. I have not, however, any really well fixed material: most of my specimens have been obtained post-mortem, and the others are rather inadequately fixed in formalin. Bauer (1931) and Bauer and Hakki (1932) report cells filled with mucin granules—a "mucoid transformation"—in their specimens.

EXPERIMENTAL PRODUCTION OF MUCOCELE OF THE GALL-BLADDER

Numerous experimenters have endeavoured to produce in animals a condition similar to the mucocele or hydrops found occasionally in man as a result of obstruction at the neck of the gall-bladder. Such an obstruction is commonly due to the impaction of a solitary stone in the neck of the gall-bladder, but may be produced in other ways. Riedel (1903) considered that the condition had a purely mechanical origin, but Aschoff (1905) thought that simple obstruction was insufficient and that an added infection was needed. He found that in dogs an aseptic tying or resection of the cystic duct did not produce such a condition, but resulted in an

atrophy of the gall-bladder. Mocquot (1909) saw a temporary mucous distension as a result of such experimental interference, but this was followed by definite contraction of the organ. Mignot, Businco (1917), Borgi (1921), Agrifolio (1923), and Petrescu (1924) failed to produce anything more than a temporary distension, followed invariably by a contraction of the organ with a progressive atrophy of the mucosa and concentration of the contained bile. Galli and Vecchi (1928) tried tying the cystic duct, introducing a sterile foreign body (human gall-stone) into the gall-bladder, infecting the gall-bladder with typhoid bacilli, and combinations of these procedures: in none of their thirty-one dogs did they produce a condition comparable with hydrops in the human.

Toida (1920), experimenting on dogs, cats, and rabbits, found that simple aseptic tying of the cystic duct, with or without a tying of the cystic artery or the introduction of a foreign body, did not produce a condition of hydrops but only a sclerosis or contraction of the bladder and a thickening of the contained bile. However, the introduction of bacteria of feeble virulence into such an obstructed gall-bladder provoked a catarrhal type of inflammation and he was thus able to produce what he described as a typical hydrops. Bacteria of a higher virulence produced a purulent inflammation.

Hunt, Davis, and Boyden (1931) tied the cystic duct in cats, and examined the results at intervals up to a fortnight. They found that only 50 per cent of the gall-bladders showed a normal mucosa; in 20 per cent it was œdematous and in 30 per cent definite inflammatory changes were present. They state that such operations in cats are always followed by some degree of cholecystitis, which ranges from the mildest inflammation to a hydropic distension of the organ, although there is no evidence of infection of the cystic bile. They conclude that hydrops of the gall-bladder may occur in the absence of infection, and believe that it is due to moderate interference with the blood-supply, to which interference the irritating action of stagnant bile may be a contributory but not essential factor. A fair criticism of their conclusions is that they observed only the immediate and early results of occlusion. Earlier writers have noted that there is sometimes a temporary distension but that a true mucocele does not eventuate under these conditions. The high proportion in which inflammatory changes were demonstrated histologically is noteworthy in view of the findings of Andrews and Hrdina (1930) and Andrews, Schoenheimer, and Hrdina (1932), who state that it is very difficult to produce stasis of any sort in the gall-bladder of the dog without the prompt onset of sepsis. When the cystic duct is tied and the gall-bladder needled, severe degenerative changes promptly appear owing to infection arising in the occluded, traumatized organ. The bile, which was sterile, promptly becomes infected by great numbers of organisms, and microscopical examination of the wall shows a marked onset of a moderately severe inflammatory process.

Bauer (1931) confirmed the findings of Toida (1920) that it is impossible to shut off the gall-bladder for any length of time by introducing a foreign body into the lumen: such bodies wander readily either into the fundus of the bladder or down the bile-ducts. He therefore tied the cystic duct in dogs, generally including the cystic artery in the ligature. Provided the vesicle was not detached from the liver he found no alteration directly attributed to the tying of the cystic artery, whose functions were taken over by anastomosing vessels. When the gall-bladder was emptied of bile and washed out with saline an immediate secretion of mucus

occurred, at first small in amount, clear and fluid, then increasing in quantity, becoming more and more dense and containing greyish-white floccules. No distension of the bladder occurred, however; it filled up slowly to a normal size. At the end of three months the condition was well marked. The mucosal cells, particularly those at the fundus, showed an increased content of mucus granules staining deeply with mucicarmine. After this period there occurred a regression, the epithelium ceased to secrete mucus, the cells tended to become flattened and to contain few granules staining with mucicarmine. At a still later period (eight months) the contents were found to be again fluid, suggesting a re-absorption or possibly a destruction of the mucus. When the gall-bladder was not emptied of its bile such a sequence could not be produced. Instead there was a degeneration of the epithelium, attributed to the toxic action of the retained bile, and mucus-producing cells were rare. The bile became greatly concentrated, but there was very little evidence that anything but water was absorbed. The introduction of a sterile gall-stone into the occluded, washed-out gall-bladder appeared to augment the intensity of the production of mucus, but again there was no distension. Inoculation of a suspension of *B. coli* of attenuated virulence into such a bladder gave a rapid distension of the organ with a clear mucoid fluid comparable with that found in a human mucocele. This result could only be obtained provided the cystic artery was intact, a fact noted previously by Toida (1920). Bauer did not follow any of these cases for more than a fortnight, at the end of which time *B. coli* could still be cultivated from the distended organ. These experiments are also recorded in a paper by Bauer and Hakki (1932), but with fewer details. They insist that a true mucin is produced by the epithelial cells of the gall-bladder in dogs and man.

AUTHOR'S EXPERIMENTS

In a number of experiments on the gall-bladder of the cat, a few have some bearing on this problem. All the experiments were performed under ether, and aseptic precautions were taken throughout. In every case the cystic duct was occluded by a ligature of silk, the cystic artery being sometimes included in the ligature but left free whenever possible. No evident difference was found at any time as a result of inclusion of the artery; there is apparently a sufficient collateral circulation from the surface of the liver to which the gall-bladder is usually closely applied in the cat. The occlusion of the cystic duct was tested when the animals were eventually killed, and in all cases the duct appeared to be completely shut by the ligature: in one case, however, after 53 days the contents of the bladder appeared to be normal bile. Although it could not be demonstrated, it appeared likely that there was an accessory duct or an anastomosis via the small tributary described by Rous and McMaster (1921). This experiment was disregarded. In two cases in which the cystic duct was occluded for six months, the common bile-duct was distinctly dilated.

In experiments where the only interference consisted of tying the cystic duct, a condition that could be described as a mucocele did not develop. Such gall-bladders were examined 4, 48, 90, and 181 days after the operation. The first two were of normal size, the third about half normal, and the last quite small. The contents were in all cases thick dark bile, which in only one case (48 days) appeared to the naked eye to be mixed with mucus. Definite histological evidence

of inflammation was to be found in all except the last. In short, these findings agree with all the previous published results—simple obstruction of the cystic duct does not lead to the formation of a mucocele. In another case an anomalous result was obtained after simple tying of the duct. This animal was killed 28 days after the operation; the vesicle was definitely but not greatly distended and appeared normal on its external surface. The contents were found to consist almost entirely of material resembling white of egg, whilst only at the fundus was there some pale yellow opaque material applied to the mucous membrane. There was histological evidence of a subsiding inflammation, but no organisms could be found in smears or sections. This experiment does not fit in with those recorded above or with previously published ones. Judging from the small amount of bile pigment present in the bladder after four weeks, it seems probable that the organ contained only a very small amount of bile or only very dilute bile at the time of operation. No other experiments show absorption of large amounts of bile in so short a time, and there was no microscopical evidence of such an absorption in this case. If this experiment is to be included in this series it should be placed rather amongst those in which the gall-bladder was emptied of its bile. I prefer to record it as an anomalous result and not to include it with either group.

In other cats, after ligating the cystic duct, the gall-bladder was emptied through a fine needle, washed with sterile saline, and left partially filled with saline. One such after 29 days was small, contained only a little mucus, and showed no histological evidence of inflammation. One left for 88 days was found to be enlarged and tense; it was distended with very thick sticky material coloured a golden brown by altered blood pigment (the wall had been deliberately damaged with forceps at the operation): no organisms could be detected, but there was definite histological evidence of a mild inflammatory reaction. A third gall-bladder after 187 days was enlarged to about twice the normal size; it contained a clear, viscid fluid like egg-white, which at the fundus was rendered opaque by numerous glistening particles of cholesterol. No histological evidence of inflammation could be found in the body of the bladder but the appearances at the fundus suggested a continued mild inflammatory lesion; no organisms could be found in smears or sections.

Attempts to produce a mucoid dilatation by injecting *B. coli* obtained from cat fæces were uniformly unsuccessful. A purulent cholecystitis resulted in every case.

DISCUSSION

It is possible, though difficult, to produce in the gall-bladder of the experimental animal a condition comparable with human mucocele. The presence of bile in the occluded bladder prevents this happening, presumably because the inspissated bile tends to produce a destruction of the epithelial lining. In a similar manner infection by organisms having an appreciable virulence does not produce such a condition; there is a purulent inflammation with destruction of mucosal cells. For the development of an experimental mucocele the gall-bladder must be emptied of all but traces of bile and a very mild inflammation be initiated. That emptying of the bile after occlusion is not of itself sufficient is shown in an experiment recorded above where after 29 days the bladder was small and shrunken, and there was no evidence of inflammation.

Toida (1920) produced the condition by injection of organisms of feeble virulence, and presumably evacuated the bile at the time of injection. Bauer (1931) produced a mucoid distension by washing out the occluded gall-bladder, but found that the condition tended to regress. He stated that there was no inflammatory reaction as a result of this procedure, but in view of the findings of Andrews and Hrdina (1930) it appears probable that a mild inflammation was set up as a result of infection at the time of the operation.

In the cases of mucocele reported here there was in every case histological evidence of a mild regressing inflammation affecting part of the mucosa. It appears possible that in these cases a mild infection resulted from the operative interference, and that the consequent mild inflammation stimulated the epithelial cells to secrete large quantities of mucus and thus produce a mucocele. The mucoid material distending the bladder is not purely mucus but a mixture of mucus and an albuminous material, as is readily seen in smears or sections. This is true of the contents of human mucoceles, but commonly the proportion of mucus is less—an albuminous fluid containing mucus. Crystals of cholesterol may be found in the human fluid as in one of the cases recorded above. It appears probable that in the production of a mucocele of the gall-bladder in man several factors must play a part: (1) Obstruction, commonly by a stone; (2) Absorption of the bile contained in the vesicle,* or its expulsion by a mucous secretion before obstruction is complete; (3) A mild continued inflammation, probably bacterial but with organisms of a virulence too low to produce a purulent reaction.

These conclusions agree with those put forward by Illingworth and Dick (1932): "the effects of obstruction of the cystic duct, however it is caused, depend on the degree and virulence of any present or potential infection. When the process is entirely non-inflammatory . . . the gall-bladder gradually contracts and its contents become inspissated. When a very mild degree of inflammatory change is present, the first effect of obstruction is to cause a secretion of mucus, and the gall-bladder then becomes distended as a mucocele, which may remain completely aseptic. When bacterial infection is present, the condition is that known as acute obstructive cholecystitis."

SUMMARY

The mucosa of the gall-bladder has a single layer of large columnar or prismatic cells thrown into folds of varying height according to the degree of distension of the organ. There are no essential differences in the appearances of the cells in men, cats, dogs, goats, sheep, pigs, or guinea-pigs. The individual cells vary considerably in shape, size, and intensity of staining according to their functional phase, but there is only one type of cell present in the normal epithelium. Within the cytoplasm are found granules of mucus staining brightly with mucicarmine. Their number varies greatly in different gall-bladders and in different parts of the same organ, but they are always present in normal tissue. It is suggested that the granules are formed in the region of the Golgi body. Experimental evidence is given that the cells can be emptied of mucus by a mild irritation.

* That bile pigment can under appropriate conditions be absorbed from the occluded gall-bladder has been shown on several occasions, and examples were found in the above experiments.

The epithelium of the rabbit's gall-bladder is readily distinguished from that of the other animals examined. The cells are more darkly staining, much narrower, have their nuclei closer to the free border, and do not show mucus granules.

Experiments are described to show that it is possible to produce a condition of mucocele in the gall-bladder of the cat by tying the cystic duct and emptying the vesicle of its contained bile. A factor in the production of this experimental mucocele is possibly a mild inflammation incidental to the operative procedures.

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SURGICAL EXPOSURE OF THE ŒSOPHAGUS

By L. O'SHAUGHNESSY and R. W. RAVEN, London

Recent advances in physical therapy and the continued mortality of surgical intervention have led many to suppose that the treatment of disease in the œsophagus should become the domain of the physical therapist and the endoscopist. The recent demonstration of a successful intervention for carcinoma of the œsophagus by Grey Turner has done much to stimulate interest in the surgical treatment of such disease. It is to be remembered that in many parts of the world treatment must *remain* surgical, and, even if it should prove that in certain cases physical

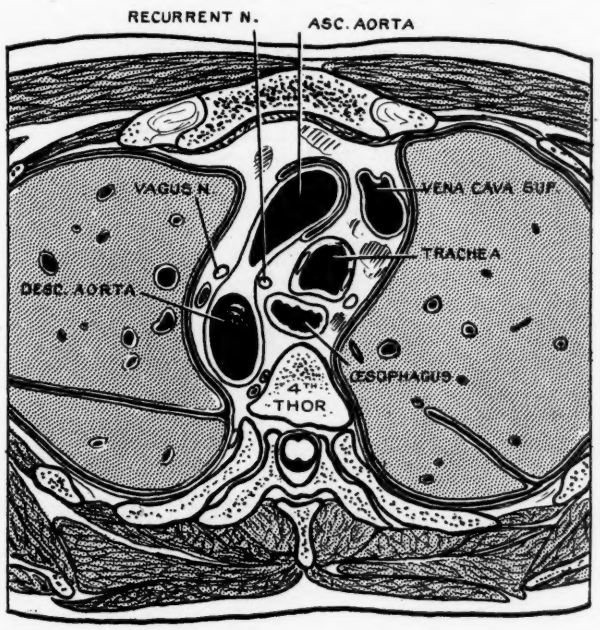

Fig. 236.—A transverse section of the thorax at the level of the 4th thoracic vertebra, showing the relations of the œsophagus above the bifurcation of the trachea. (*After Eycleshymer and Schoemaker.*)

therapy is to be preferred, it is essential that surgery should be in a position to offer a less fatal alternative than is at present the case. Innocent tumours of the œsophagus are rarely diagnosed, and in most of the recorded cases diagnosis has only followed exploratory operation; it may be assumed that more frequent exploration might lead to the more frequent discovery of conditions for which surgery can provide a dramatic cure. Some cases of this kind operated on by Sauerbruch have recently been recorded by Krauss, and Ohsawa has also extirpated a myoma of the œsophagus with successful results.

The initial difficulty in œsophageal surgery is adequate exposure of the organ,

and this alone will be considered here. A series of transverse sections (*Figs.* 236–238) give an impression of the apparently complex relations of the œsophagus,

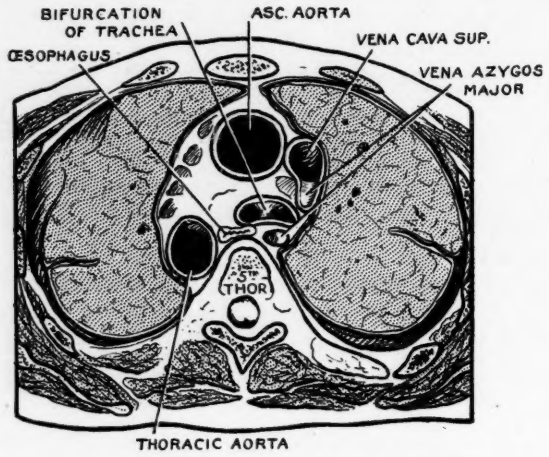

FIG. 237.—A transverse section of the thorax at the level of the 5th thoracic vertebra, showing the relations of the œsophagus at the bifurcation of the trachea. (*After Professor R. J. A. Berry.*)

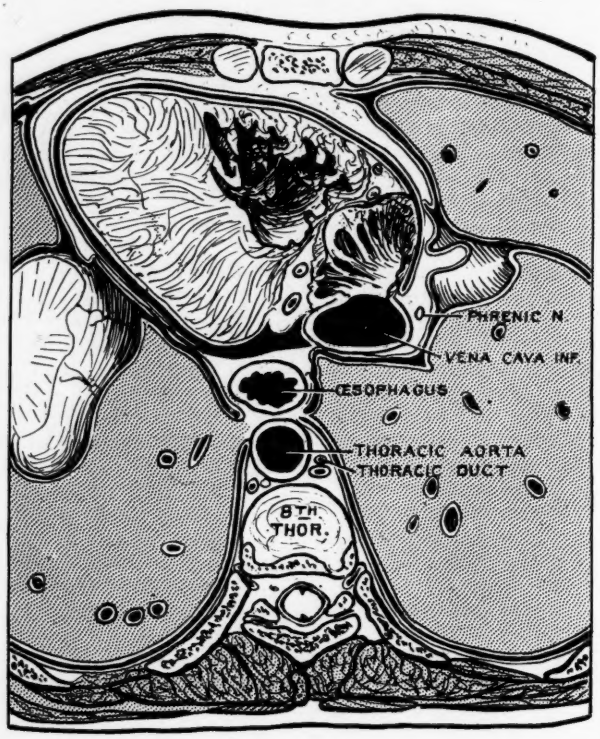

FIG. 238.—A transverse section of the thorax at the level of the 8th thoracic vertebra, showing the relations of the œsophagus below the bifurcation of the trachea. (*After Eycleshymer and Schoemaker.*)

but the main structures are easily identified if an exposure based on the lines laid down in this paper is employed. A series of dissections has been carried out, and

careful measurements have been made of the length of the œsophagus which may be displayed at various levels and the depth from the surface at which it lies. At the same time the copious literature of the œsophagus has been studied, and reference will be made to some papers which are of special assistance to those who contemplate a surgical attack on the organ.

EXPOSURE OF THE CERVICAL ŒSOPHAGUS

Exposure of the cervical œsophagus has been carried out in cases of carcinoma, pharyngeal diverticula, and for the extraction of foreign bodies.

Some early cases of excision of a carcinoma of the cervical œsophagus by Sauerbruch are reported in detail by Schelbert. One of these is of special interest as the growth extended into the upper part of the thoracic inlet. A somewhat similar case has been reported recently by Evans, and Küttner has also recorded a successful case in some detail. In these cases the tumour had invaded the larynx, and this organ was extirpated as well as a segment of the œsophagus. Despite

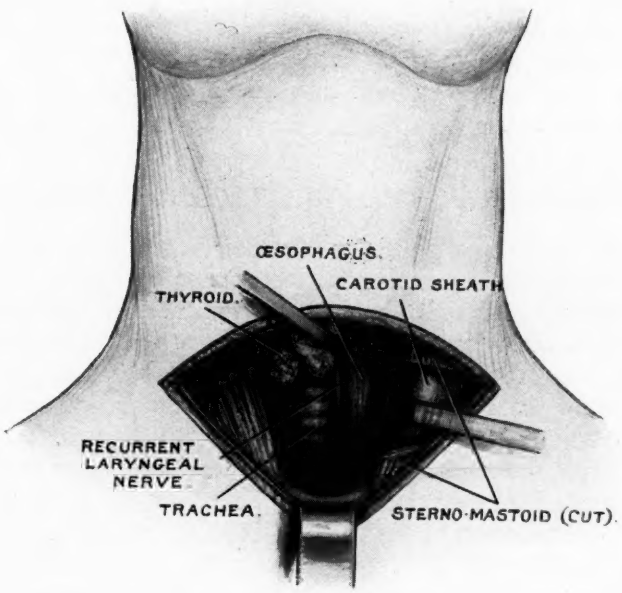

FIG. 239.—Exposure of the cervical œsophagus at the thoracic inlet through a curved incision and division of the left sternomastoid muscle. The left carotid sheath is retracted to the left, and the left lobe of the thyroid gland is retracted to the right.

this mutilation, the patients were able to talk, although in a low tone, and it is recorded by Evans that his patient was able to carry out her own shopping without difficulty.

There are very many accounts of operation for pharyngeal diverticula in the literature. One of the most comprehensive is by Wilkie and Hartley. Approach is by a longitudinal incision along the anterior border of the sternomastoid, and after division of the middle thyroid vein a lateral retraction of the carotid sheath affords exposure of the sac.

Modern endoscopy has rendered the classical intervention of cervical œsophagotomy for the extraction of a foreign body almost obsolete. A very complete account of the indications, the method, and the literature are given by von Häcker and Lotheissen.

Technique (*Fig.* 239).—The patient lies on his back, with the head fully extended and rotated to the right. An incision is made 11 cm. long, commencing at the left sternoclavicular joint and passing upward along the anterior border of the sternomastoid muscle. The anterior border of the sternomastoid is defined and the muscle is retracted outwards; in this way the intermediate tendon of the omohyoid muscle is exposed and retracted upwards. Ligature and division of the middle thyroid vein constitutes the next step of the operation. The carotid sheath is then exposed and retracted outwards, and the left lateral lobe of the thyroid gland, the sternohyoid, and sternothyroid muscles are identified and retracted inwards. The inferior thyroid artery is exposed in the lower part of the wound. The left recurrent laryngeal nerve is seen lying posterior to the lateral border of the trachea and in front of the œsophagus. The œsophagus, as it lies between the trachea and the vertebral bodies, is exposed in a length of 9 cm.; at the level of the upper border of the manubrium sterni its depth from the surface is 6 cm.

In his operation for the collo-abdominal extirpation of the œsophagus Grey Turner makes a transverse incision in the neck and divides the sternomastoid muscle. In our dissections we found that this method enabled 11 cm. of the œsophagus to be exposed.

EXPOSURE OF THE THORACIC ŒSOPHAGUS

The thoracic œsophagus has been exposed in cases of carcinoma, benign tumour, diverticulum, and for the extraction of foreign bodies. Two routes are available for exposure—the mediastinal and the transpleural. Mikulicz was perhaps the first surgeon to make a determined attempt to exploit the surgery of the thoracic œsophagus, and, after repeated trials of the mediastinal route, he came to the conclusion that only the transpleural route could give adequate exposure. The chief modern advocate of the transpleural route is Sauerbruch. Enderlen, on the other hand, preferred the mediastinal route, and his account of the surgery of the posterior mediastinum is of the utmost value. Lilienthal still employs this approach, and it may be noted that one of the three cases in the world literature up to 1933 in which natural swallowing was restored after excision of a carcinoma was carried out by him. All authorities are agreed that the mediastinal approach is to be preferred in such cases as impaction of a foreign body necessitating œsophagotomy, in intervention for perforation or rupture of the organ, or in extirpation of small diverticula which have perforated into a bronchus. In this type of case it is a considerable advantage to be in a position to leave a large open wound for drainage.

The merits and disadvantages of the mediastinal approach are illustrated by a recent operation which one of us (L. O'S.) performed. The œsophagus was approached by a posterior mediastinotomy in the region of the lung root. A tumour was exposed which was adherent to the left bronchus, and separation could not be effected. The intervention lasted for one hour, and the wound healed by first intention. Only at autopsy some four months later was it disclosed that the tumour was actually a carcinoma of the left bronchus which had invaded the

œsophagus. With a better exposure this diagnosis should have been established at the operation, but on the other hand the immediate post-operative recovery might have been more delayed.

In exposing the upper thoracic œsophagus by the transpleural route Sauerbruch resects the second and third ribs from the sternal margin for 6 cm. of their extent, incises the sternoclavicular joint and dislocates the sternal end of the clavicle, and finally resects a portion of the first rib. The pleura is opened by a vertical incision and the œsophagus identified as it lies behind the trachea. Barrett has recorded an operation by Romanis in which a diverticulum was removed which opened into the œsophagus just below the level of the azygos vein. Approach in this case was made through an incision in the sixth intercostal space.

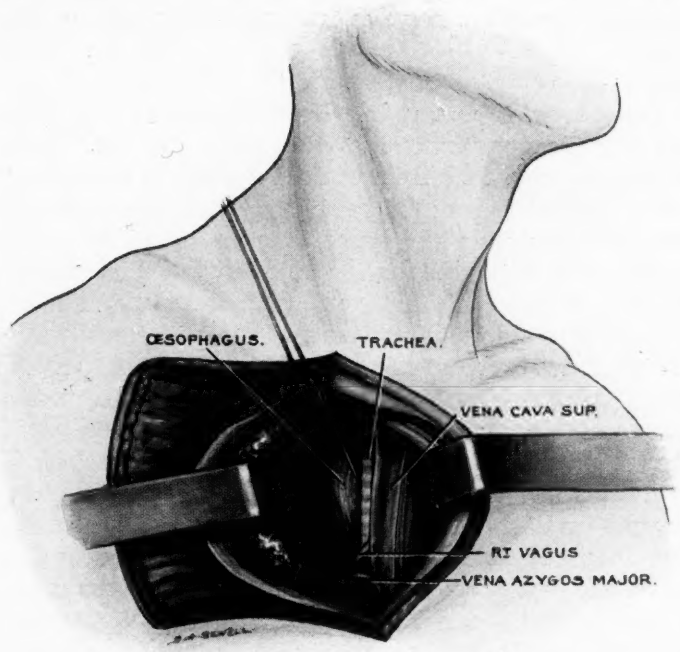

FIG. 240.—Exposure of the thoracic œsophagus above the bifurcation of the trachea by the right transpleural route. The right lung is retracted outwards and the œsophagus is seen behind the trachea and crossed by the vena azygos major and the right vagus nerve.

For his successful case of radical operation for carcinoma Torek made an incision along the whole length of the seventh left intercostal space. The fourth, fifth, sixth, and seventh ribs were divided in the region of the tubercle and the pleura incised. With this exposure an excision of the entire œsophagus from the diaphragm to the thoracic inlet was carried out under vision. Kirschner has used the same interspace in displaying the lower œsophagus and the region of the cardia. Division of the seventh costal cartilage and the left rectus permits of a wide exposure of the diaphragm, and if necessary this muscle is divided in a line stretching from the œsophageal hiatus to the periphery. Hedblom and Zaaiger have employed a very similar approach, but these authorities consider that a preliminary resection of the lower ribs carried out some ten days before the final operation facilitates the subsequent exposure. A left transpleural approach to the

lower œsophagus is also used by Sauerbruch, and this route was adopted by Eggers in his successful case.

Gregoire has described in minute detail an extrapleural approach to the lower end of the thoracic œsophagus. He resects the twelfth rib on the left side, and after simple division of the tenth and eleventh ribs the pleura is separated from the costovertebral sulcus. The œsophagus is exposed between the aorta on the medial side and the lung, covered by the separated costal pleura, on the lateral side. By incising the diaphragm and so exposing the cardiac end of the stomach Gregoire has carried out an œsophagogastrostomy by this route.

Lilienthal enters the mediastinum after resection of the ninth rib on the left side. According to the exposure required, further ribs are excised after separation of the parietal pleura has been begun. Lilienthal mentions the descending thoracic aorta and the great splanchnic nerve as important landmarks in the initial stages of the operation.

Technique.—

1. *Right Transpleural Exposure of the Upper Œsophagus* (*Fig.* 240).—The patient lies on his back with the upper extremities extended by the side. An incision 10 cm. long is made over the second rib from without inwards to the sternum. It is then carried vertically downwards over the sternum to the fourth costochondral junction and from thence outwards in the line of the fourth rib for 10 cm. This flap, consisting of the skin, superficial and deep fasciæ, and costosternal portion of the pectoralis major muscle and the pectoralis minor muscle, is dissected from the deeper structures and reflected outwards. The periosteum is reflected from the second and third ribs over 12 and 14 cm. of their length respectively, and similar lengths of these ribs, with their costal cartilages, are removed. The internal mammary artery and veins are exposed in the inner part of the wound. An incision is made in the second intercostal space to open the pleural cavity. The right lung is retracted outwards and downwards and the following structures are identified: The superior vena cava with the right phrenic nerve and accompanying blood-vessels is seen in the medial part of the wound. The vena azygos major is seen arching over the root of the lung to join the superior vena cava. The trachea is easily identifiable, and the right vagus may be found in a triangle bounded by the trachea, the vena azygos major, and the superior vena cava. The vena azygos major is divided and the mediastinal pleura incised to expose the œsophagus as it lies behind the trachea and above the right bronchus. In this way 8·5 cm. of the œsophagus may be exposed—the upper limit being the thoracic inlet and the lower limit the bifurcation of the trachea. The exposed œsophagus lies at a depth of 7·5 cm.

2. *Right Transpleural Exposure of the Lower Œsophagus* (*Fig.* 241).—The patient lies on the left side, with a pillow under the ribs and the right arm held by an assistant as in the operation of paravertebral thoracoplasty. An incision is made over the sixth rib from the costal cartilage to the inferior angle of the right scapula. A subperiosteal resection of some 26 cm. of the sixth rib is then carried out. An incision is made in the sixth intercostal space and the pleural cavity opened. After lateral retraction of the right lung the following structures are seen anterior to the œsophagus: the bifurcation of the trachea, the left bronchus, the pericardium, and the diaphragm. Posteriorly are found the vena azygos major and the thoracic duct. Near the diaphragm the œsophagus becomes anterior to the descending thoracic

aorta, and above it is crossed by the vena azygos major. In this way the œsophagus is exposed between the lung root and the diaphragm in a length of 14 cm. Division and ligature of the azygos vein enable the organ to be followed up to a rather higher level, so that in all 16 cm. may be exposed. The œsophagus lies at a depth of 12 cm.

3. *Left Transpleural Exposure of the Lower Œsophagus* (*Fig.* 242).—The patient lies on the right side with a cushion beneath the ribs and the arm held by an assistant as for a paravertebral thoracoplasty. An incision is made over the sixth rib,

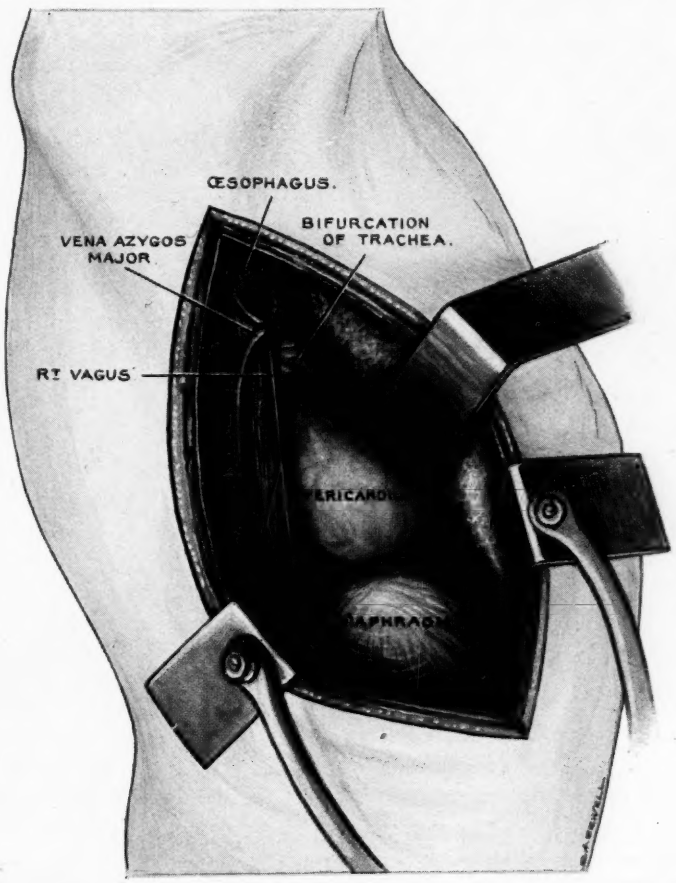

FIG. 241.—Exposure of the thoracic œsophagus below the bifurcation of the trachea by the right transpleural approach. The right lung is retracted forward and the œsophagus is seen lying between the bifurcation of the trachea, left bronchus, and pericardium anteriorly, and the vena azygos major posteriorly.

commencing at the costal cartilage and extending upwards and backwards over the inferior angle of the scapula. The periosteum covering this rib is elevated and 24 cm. of the rib removed. The pleural cavity is opened through the sixth intercostal space. The left lung is retracted forwards and the œsophagus is identified lying between the descending thoracic aorta behind and the pericardium in front. The diaphragm is below, and in the inner part of the wound the termination of the left phrenic nerve with accompanying blood-vessels may be seen. The

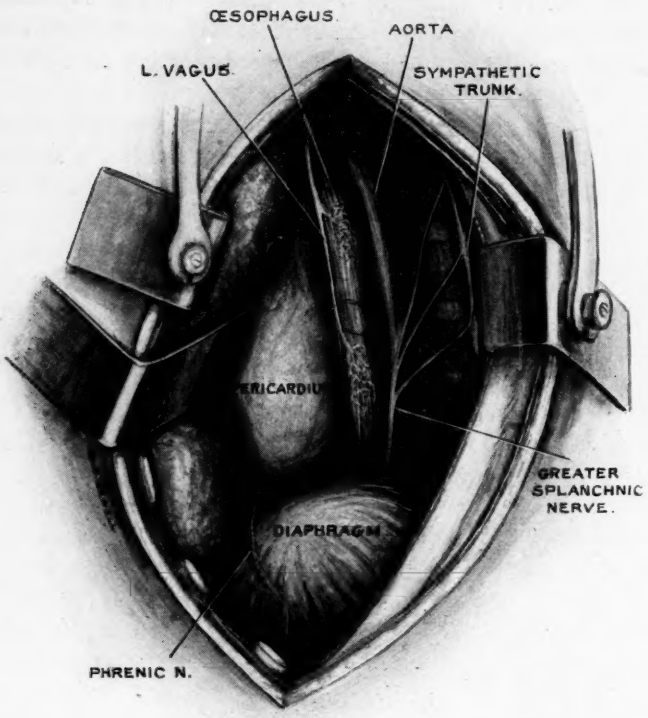

FIG. 242.—Exposure of the thoracic œsophagus from the arch of the aorta to the diaphragm by the left transpleural approach. The left lung is retracted forwards and the œsophagus is seen lying between the descending thoracic aorta behind and the pericardium in front. The latter constitutes the greatest obstacle to clear vision of the œsophagus.

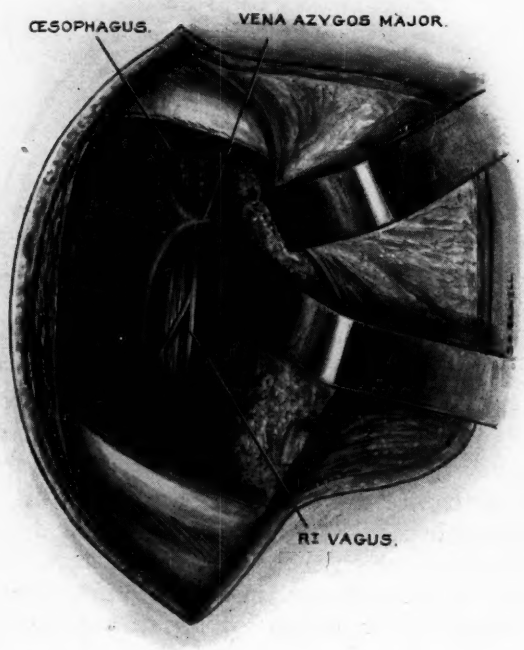

FIG. 243. — Exposure of the thoracic œsophagus at the bifurcation of the trachea. The parietal pleura has been separated from the vertebral bodies in a downward direction. The œsophagus is exposed between the separated lung and pleura and the bodies of the vertebræ. The vena azygos major is the important landmark for the œsophagus as it crosses behind the latter to join the superior vena cava.

pericardium constitutes the greatest obstacle to clear vision, but after division of the mediastinal pleura the œsophagus may be drawn outwards and the left vagus with its plexus is easily identified. In this way the œsophagus is exposed between the arch of the aorta and the diaphragm in a length of 14 cm. and at a depth of 9·5 cm.

4. *Right Mediastinal Exposure of the Œsophagus* (*Fig.* 243).—The patient lies prone on the table with the right arm held by an assistant as in the operation of paravertebral thoracoplasty. The incision commences 5 cm. to the right of the middle line at the level of the second rib and is carried downwards to the angle of the right scapula, at which point it curves outwards to terminate at the level of the eighth rib in the posterior axillary line. After division of the trapezius and rhomboid muscles the scapula is mobilized, as in the operation of thoracoplasty. The periosteum over the fifth, sixth, and seventh ribs, together with the tips of the transverse processes of the corresponding vertebræ, are removed. The lengths of ribs removed are: fifth rib, 7·5 cm.; sixth rib, 8·5 cm.; seventh rib, 7·5 cm.

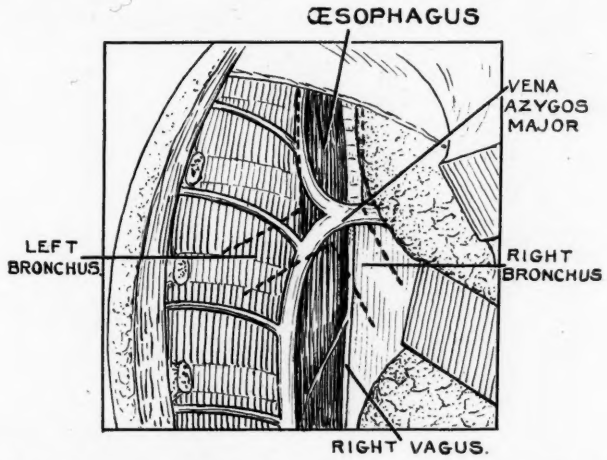

FIG. 244.—A diagram to show the exact relations of the œsophagus at the level of the bifurcation of the trachea. The œsophagus lies posteriorly to the commencement of the left bronchus and to a lesser extent it comes into contact with the commencement of the right bronchus.

The parietal pleura is gently separated from the vertebral bodies in a downward direction until the œsophagus is exposed lying between the vertebral column and the separated lung and pleura. The lung and pleura are on the right of the œsophagus, and the bodies of the vertebræ are on the left; in front is the trachea and the left bronchus, and at the actual bifurcation of the trachea the commencement of the right bronchus also forms an anterior relation (*Fig.* 244). The vena azygos major passes upwards on the left margin of the œsophagus and at the level of the root of the right lung passes behind the œsophagus to join the superior vena cava. The right vagus nerve is seen on the right of the œsophagus giving a well-marked branch to the posterior aspect. In this way 8 cm. of the œsophagus may be exposed at a depth of 6·5 cm.

5. *Left Mediastinal Exposure of the Lower Œsophagus* (*Fig.* 245).—The patient is placed prone on the table with the left hand held above the head by an assistant. The incision commences at the level of the third rib, three finger-breadths below

the mid-line, and extends vertically downwards until it takes an outward sweep along the axis of the eleventh rib. The periosteum covering the posterior aspects of the ribs number four to eleven is exposed and elevated, and 6 cm. of each rib is removed. The length removed diminishes towards each extremity of the wound. The parietal pleura is gently separated in a downward direction, commencing near the mid-line. The œsophagus lies between the separated lung and pleura and the descending thoracic aorta. To the inner side of the aorta the bodies of the thoracic

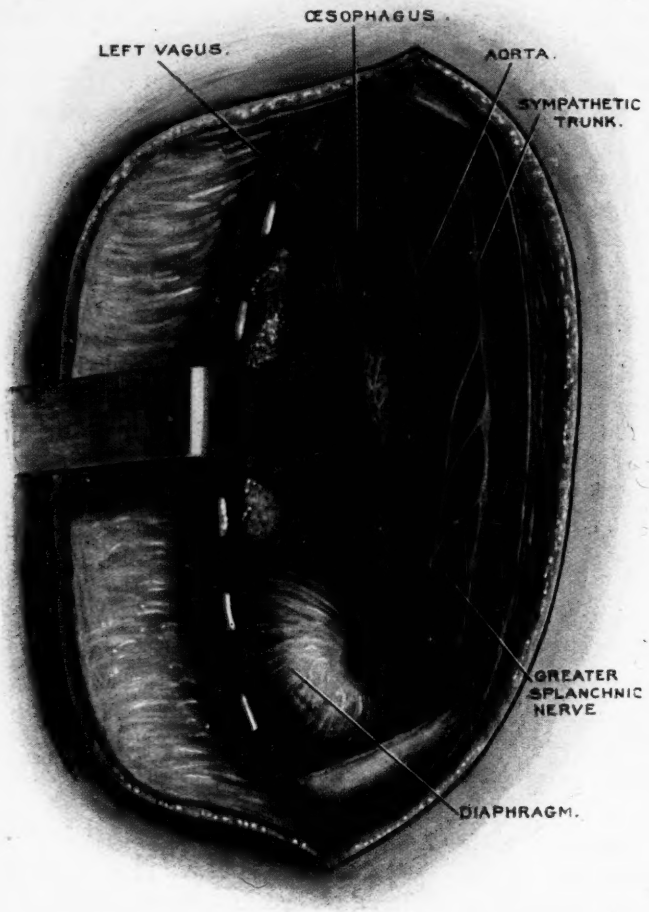

FIG. 245.—Exposure of the thoracic œsophagus from the arch of the aorta to the diaphragm by the left mediastinal approach. The parietal pleura is separated from the vertebral bodies in a downward direction and the œsophagus is exposed between the separated lung and pleura and the descending thoracic aorta.

vertebræ may be seen with the thoracic trunk of the sympathetic and the great splanchnic nerve. The œsophagus disappears above under the arch of the aorta, and, below, it may be seen passing through the œsophageal hiatus of the diaphragm. In this way the œsophagus may be exposed from the arch of the aorta to the diaphragm in a length of some 14 cm. A similar incision but with the sacrifice of fewer ribs permits of a more limited exposure. The œsophagus lies at a depth of 7·5 cm.

THE ABDOMINAL ŒSOPHAGUS

Reference has already been made to the successful operation by Grey Turner in which a carcinoma of the œsophagus was extirpated by the collo-abdominal route. His abdominal approach was made through a median incision, and after separation of the left lobe of the liver from the diaphragm, the œsophagus was exposed.

A carcinoma of the lower œsophagus was excised by Gohrbrandt from below the diaphragm and continuity was restored. The abdomen was opened by an oblique incision below the left costal border. The cardiac end of the stomach was drawn towards the surface, and after section of the left vagus and transverse division of the peritoneum a blunt separation of the lower end of the œsophagus was carried out. Free mobilization was only possible after section of the right vagus. Gohrbrandt recommends that separation should be carried out by the index finger rather than by any special form of instrument, in order to avoid an accidental wound of the pleura as the viscus is followed into the mediastinum. Grey Turner has also used this method. Clairmont has employed this route for the excision of an epiphrenal diverticulum. Grey Turner has made use of the abdominal approach for the operation of œsophagogastrostomy in cases of cardiospasm and simple stricture, and a similar approach has been used by Fromme. Ohsawa has recently reported 14 cases of excision of the lower œsophagus with restoration of continuity, and in 8 of these cases healing resulted. In cases when the exact site of the lesion is doubtful he begins by an abdominal approach. If extirpation by this route seems impracticable, he divides the costal cartilage after the manner of Marwedel and then opens the chest by incising the diaphragm from the costal margin to the œsophageal hiatus.

Technique.—

1. *Simple Laparotomy.*—The patient lies on his back in the reversed Trendelenburg position—that is, with the foot of the table inclined downwards. A median incision from the ensiform to the umbilicus serves to open the abdominal cavity. After division of the left lateral ligament the left lobe of the liver may be retracted to the right and the region of the cardia exposed. The stomach is drawn downwards and the abdominal œsophagus comes into view. After transverse division of the peritoneum blunt dissection, followed by gentle traction, renders it possible to expose some 5 cm. of the œsophagus at a depth of 13 cm.

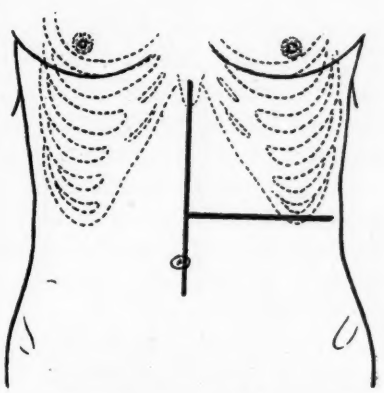

FIG. 246.—The skin incision for the exposure of the abdominal œsophagus by the Marwedel method.

2. *Marwedel Method (Modified)* (*Figs.* 246–248).—The patient lies in the reversed Trendelenburg position and a vertical incision is made from the root of the ensiform process to a point 2 cm. below the umbilicus. At the juncture of the upper two-thirds and lower one-third of this line a second horizontal incision passes out to the costal border (*Fig.* 246). A triangular musculo-cutaneous flap is dissected upward to expose the lower costal cartilages on the left side. After section of the sixth and seventh costal cartilages at their

junction with the sternum a subperiosteal resection of some 2 cm. of the seventh, eighth, and ninth ribs at the costochondral junction is carried out (*Fig.* 247). This manœuvre enables the left costal border to be lifted up in the manner of a trap-door, and after division of the left lateral ligament and retraction of the left lobe of the liver an excellent exposure of the œsophagus is obtained. In this way, after division of the peritoneum, mobilization of the œsophagus, and section of both vagi, some 8 cm. of the œsophagus may be exposed. The original depth from the surface is 14 cm., but mobilization of the organ, together with retraction of the costal flap, enables the œsophagus to be brought up almost to the surface of the wound (*Fig.* 248).

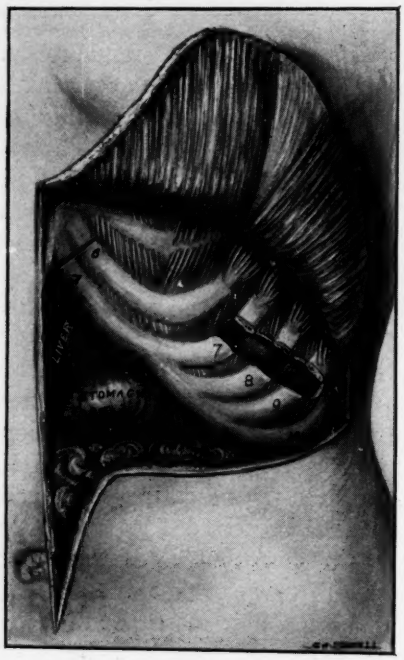

FIG. 247.—The intervention on the costal margin as the second stage in the exposure of the abdominal œsophagus by the Marwedel method. The diagram shows the formation of the hinged flap, which is turned upwards and outwards.

CONCLUSION

In approaching the œsophagus by the transpleural route in the dissections, rib resection has always been practised. A similar exposure may be obtained by an intercostal incision with removal of segments of the ribs posteriorly, as practised by Lilienthal, or by division of the costal cartilages anteriorly, as done by Kirschner. In a recent operation by one of us (L. O'S.) the former manœuvre considerably assisted in carrying out a left transpleural exposure of the œsophagus.

The upper œsophagus from the level of the thoracic inlet to the lung root is best exposed by a right transpleural approach.

The œsophagus in the region of the lung root is best exposed by a right mediastinal approach. Excision of short segments of rib renders adequate exposure difficult, but if the lengths described are excised, there is ample room for the assistant's hand to retract lung and pleura

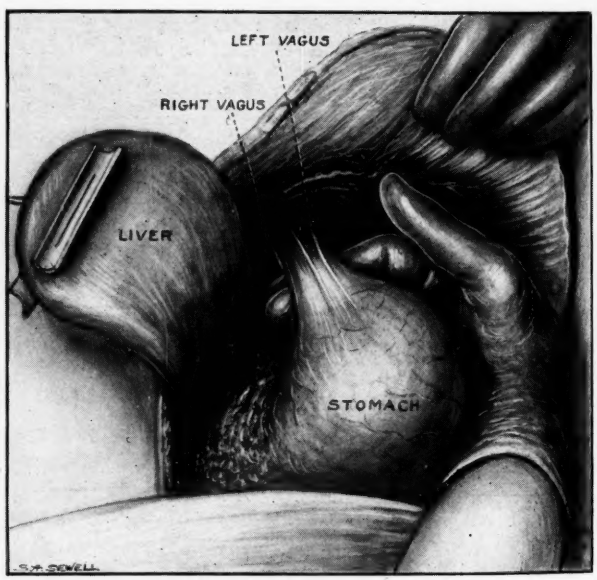

FIG. 248.—Exposure of the abdominal œsophagus by the Marwedel method. The left lobe of the liver has been mobilized to the right and the hinged flap consisting of the lower ribs has been turned upwards and outwards and the abdominal œsophagus is lifted to the surface.

without encroachment on the operative field. It is also possible to expose this region by a right transpleural approach after ligature and division of the azygos vein.

The lower œsophagus—from the level of the aorta to the œsophageal hiatus in the diaphragm—is best exposed by a left transpleural approach. If there is any doubt as to the upper limit of the lesion, the right transpleural approach should be substituted, because ligature and division of the vena azygos major enables the organ to be followed upwards, while separation of the œsophagus from behind the arch of the aorta is an intervention of great magnitude. It is also possible to expose the lower œsophagus by the mediastinal route, and here also approach from the left side is to be preferred.

Approaching the œsophagus from below, the modified Marwedel incision seems to be the method of choice if a difficult operation such as local resection with restoration of continuity is contemplated. In suitable cases the operation could be carried out in two stages, with mobilization of the costal arch as the first. Testing the method of Ohsawa on the cadaver, we have found that his method of opening the chest from the abdomen when following the œsophagus up towards the lung root is open to some objections: an incision in the diaphragm stretching from the œsophageal hiatus to the costal border is liable to wound the pericardium, and the closure of this incision offers great technical difficulty. At the same time this method does permit of a preliminary exploration from the abdomen, and although we personally should prefer to begin with the left transpleural approach and then, if access to the cardiac end of the stomach was desired, divide the diaphragm from above—with the pericardium intact—the results obtained by Ohsawa are so remarkable that it seems impossible to dismiss his suggestion lightly.

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THE EXPERIMENTAL PRODUCTION OF CHOLESTEROSIS (STRAWBERRY) GALL-BLADDER

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THE stippled deposits of cholesterol found in the mucous membrane of the gall-bladder in the condition known as strawberry or cholesterosis gall-bladder have excited interest partly because of their possible significance in the etiology of gall-stones, and partly because of their possible relation to clinical symptoms. There are two chief theories on their mode of development. The first, which has the support of Aschoff and Bacmeister, Illingworth, and Berendes, postulates that normally the gall-bladder mucosa absorbs cholesterol from the bile, and that in these cases of cholesterosis gall-bladder there is a breakdown in this absorbing mechanism so that the cholesterol becomes deposited out in the wall of the gall-bladder; various causes for the breakdown, such as chronic inflammation and lymphatic obstruction, have been suggested. On the other hand, there is the theory recently supported by Elman and Graham that the condition results from a breakdown in a normal cholesterol-secreting mechanism in the gall-bladder. The object of the present paper is to present experimental evidence that neither of these theories is necessarily correct, and to discuss the possible clinical importance of this.

LITERATURE

Most of the recorded experimental work has been done on the rabbit, though Piccaluga has claimed to have produced the condition in the dog. The dog, however, may normally show deposits of cholesterol in the mucosa of the gall-bladder (Boyd, Chauffard). The gall-bladder of the rabbit, on the other hand, is normally quite free from cholesterol deposits, and most experimental work has been done in this animal. It is well known that if the rabbit is fed with large doses of cholesterol the blood-cholesterol rises and deposits are found in various situations, the most striking being the liver, aorta, suprarenal, and kidney. Though deposits of cholesterol may rarely be found in the gall-bladder under such circumstances, it is generally agreed that they are insignificant in amount. If cholesterol is deposited in the biliary passages at all, it seems to be more frequent in the bile-ducts than in the gall-bladder (Chalatow, Zinserling). Illingworth has shown, however, that if, in addition to the cholesterol feeding, chronic inflammatory changes are induced in the gall-bladder, a condition histologically comparable in every respect with the cholesterosis gall-bladder of man can be produced. Illingworth produced his inflammatory changes by the direct injection of short-chained streptococci into the gall-bladder wall, and he concluded, partly from histological evidence and partly from chemical evidence, that the deposits of cholesterol resulted from an interference with a normal cholesterol-absorbing mechanism in the gall-bladder.

SCOPE OF PRESENT EXPERIMENTS

Experiments were performed on nineteen rabbits, the general principle of which was that the blood-cholesterol was raised by feeding and at the same time attempts were made to produce varying degrees of inflammatory reaction in the gall-bladder by such procedures as pinching with forceps, puncturing with a hypodermic needle, tying the cystic duct, or injecting organisms intravenously. The animals were given ½ to 1 grm. of cholesterol daily for periods up to two and a half months, by which time the blood-cholesterol had risen from the normal region of 100 mgrm. per 100 c.c. to the region of 1000 mgrm. Any operative procedure on the gall-bladder was usually carried out before starting the cholesterol feeding. Periodic estimations were made of the blood-cholesterol, and in some cases of the bile-cholesterol. At the conclusion of the experiment the animal was killed, a general post-mortem examination made, and the gall-bladder removed with a piece of adjacent liver and fixed in formalin together with any other organs or tissues to be examined. Frozen sections were subsequently cut, stained with Sudan III, and examined with the polarizing microscope.

Results.—A summary of the experimental procedures performed, the main chemical findings, and the condition of the gall-bladder at the conclusion of the experiment is given in the table on p. 380.

THE PATHOLOGICAL AND HISTOLOGICAL FINDINGS

The animals at the post-mortem examination showed the usual infiltrations with cholesterol that are met with in rabbits after prolonged hypercholesterolæmia. Thus the liver was as a rule pale to the naked eye, and grossly infiltrated with cholesterol microscopically, and the characteristic deposits were present in the aorta often in marked degree. In addition, the region of the incision in the abdominal wall was usually pale like the liver, and microscopical examination confirmed that it too was grossly infiltrated with cholesterol, chiefly in the areas of inflammatory cell infiltration (*Figs.* 249, 250).

The appearance of the gall-bladder varied. In some of the animals no inflammatory changes were produced in the gall-bladder by the experimental procedure employed. Such was the case, for example, in the animals injected intravenously with short-chained streptococci. In these the gall-bladder was normal on both naked-eye and microscopical examination, and also devoid of cholesterol deposits. In other experiments, in which the external injury to the gall-bladder had been slight, there was inflammatory thickening of the serosa, characterized by fibrosis and some mononuclear proliferation, while the other coats were practically free of inflammatory changes. In these cases there were deposits of cholesterol in the inflamed areas in the serosa, but not in the rest of the gall-bladder (*Figs.* 251, 252).

On the other hand, in the animals in which the injury to the gall-bladder had been severe, there were fibrosis and gross inflammatory changes throughout the whole of the gall-bladder, often accompanied by sloughing and disappearance of the epithelial lining, and deposits of cholesterol could be seen microscopically scattered throughout the whole thickened gall-bladder. Often the gall-bladder was surrounded by adhesions or buried by overlapping lobes of the liver, and cholesterol

SUMMARY OF EXPERIMENTS

EXP. No.	OPERATIVE PROCEDURE	BLOOD-CHOLESTEROL AT START OF EXP.	BLOOD-CHOLESTEROL HIGHEST REACHED	BILE-CHOLESTEROL AT START OF EXP.	BILE-CHOLESTEROL HIGHEST REACHED	CONDITION OF GALL-BLADDER POST MORTEM	CHOLESTEROL DEPOSITS IN GALL-BLADDER
		Mgrm. per 100 c.c.		Mgrm. per 100 c.c.			
1	Injection of olive oil into G.B.	105	875	172 *	415	Normal ..	Absent
2	Pinching G.B. with forceps	115	1330	157 *	250	Thickened and opaque	Present: chiefly in subserosa
3	As 2	100	910	137 *	490	Thickened and opaque	Present: slight in amount
4	Repeated aspiration of G.B.	125	924	55	150	Normal ..	Absent
5	As 4	195	860	45	200	Buried in adhesions	Present in adhesions not in G.B.
6	As 4	145	1300	50	340	Normal ..	Absent
7	As 4	88	1220	—	250	Post-mortem decomposition present and not examined microscopically	
8	As 4	94	1350	120	170	Thickened and opaque	Not microscoped
9	As 4	120	1030	—	200	Thickened and opaque	Well marked deposits
10	Pinching with forceps and tying cystic ducts	150	1140	—	—	Normal ..	Absent
11	As 10	150	960	—	—	Markedly thickened and inflamed	Present
12	As 10	150	900	—	—	Normal ..	Absent
13	As 10	105	810	—	—	Slightly thickened..	Absent
14	Intravenous injection of streptococci from case of gall-stones	145	790	—	—	Normal ..	Absent
15	As 14	90	790	—	—	Normal ..	Absent
16	As 14	120	690	—	—	Normal ..	Absent
17	Cystic duct tied; G.B. pinched with forceps	—	—	—	—	Markedly thickened and inflamed	Present in slight amounts
18	As 17	—	685	—	—	Slightly inflamed	Present
19	As 17	—	1000	—	—	Markedly thickened	Present

* After 17 days' feeding

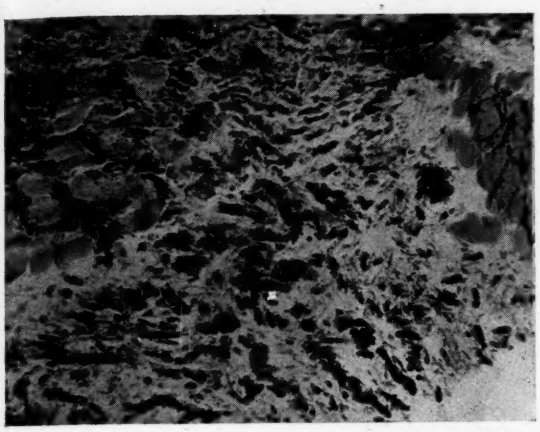

FIG. 249.—Section of anterior abdominal wall in the region of the incision, stained with hæmatoxylin and Sudan III, and showing collections of granular chronic inflammatory cells interspersed between the muscle fibres. (× 45.)

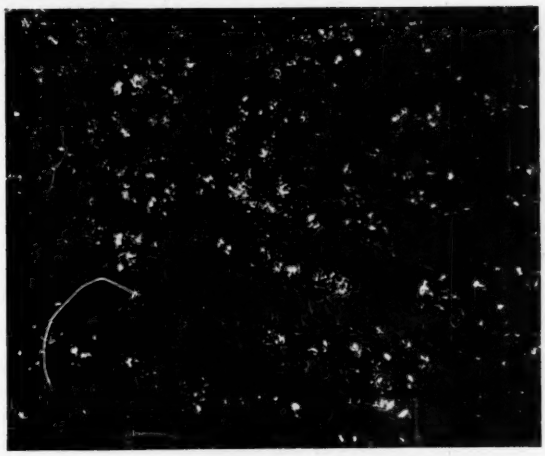

FIG. 250.—Part of the same section as *Fig.* 249 examined with the polarizing microscope, and showing the doubly refractile cholesterol. (× 65.)

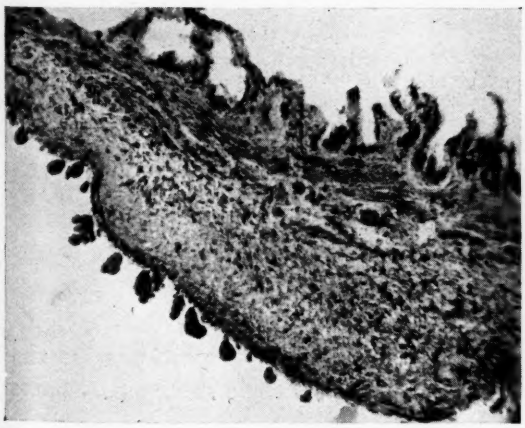

FIG. 251.—Section of gall-bladder stained with hæmatoxylin and Sudan III, showing above the villi of the mucosa of the gall-bladder, and below the grossly thickened serous coat containing numerous granular inflammatory cells. (× 45.)

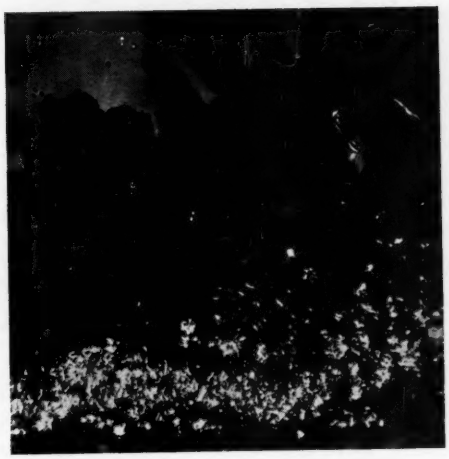

FIG. 252.—Part of the same section as *Fig.* 251 examined with the polarizing microscope, and showing the doubly refractile cholesterol confined to the thickened serous coat. (× 65.)

could be demonstrated in the adhesions. But in a few of the animals the inflammatory changes were most marked towards the epithelial surface, accompanied by deposits of cholesterol in the villi of the mucosa (*Figs.* 253, 254). A picture was thus produced exactly comparable with that found in the strawberry gall-bladder of man. The cholesterol deposits stained with Sudan III, and were

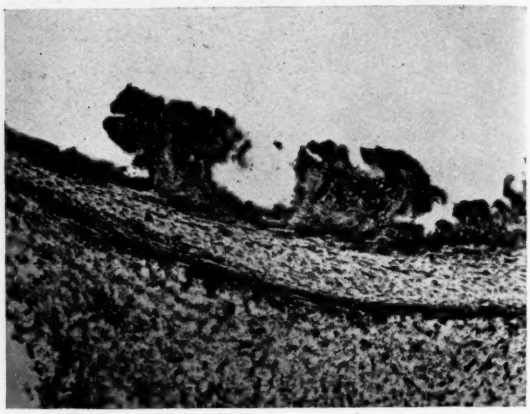

FIG. 253.—Section of gall-bladder stained with hæmatoxylin and Sudan III, and showing above the epithelial surface and two villous folds, and below the adjacent liver. The villous folds are infiltrated with chronic inflammatory cells. (× 50.)

doubly refractile on examination with the polarizing microscope, and on examination with the high power seemed to be chiefly present in phagocytic cells, as in *Fig.* 255, which shows similar cells from the anterior abdominal wall. The presence of cholesterol in the gall-bladder thus depended on whether inflammatory changes were present, and their situation. It is worthy of note, however,

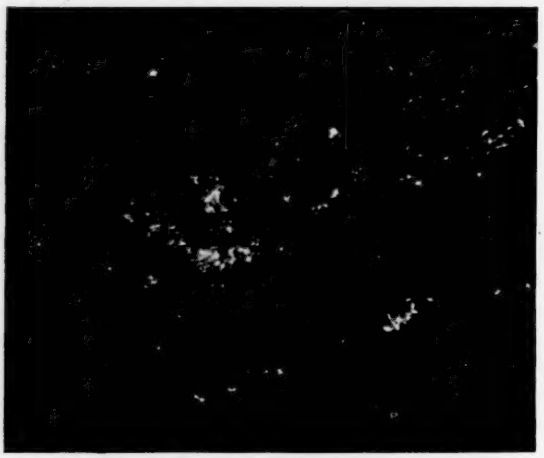

FIG. 254.—Part of the same section as *Fig.* 253 examined with the polarizing microscope, and showing the doubly refractile cholesterol in the stroma of the villi. (× 75.)

that the amount of cholesterol deposited was not directly proportionate to the amount of inflammatory reaction, and in the grossly thickened fibrotic gall-bladders the deposits were relatively scanty.

The contents of the gall-bladder in the cases in which only minor trauma had been inflicted consisted of apparently unaltered bile, but in the cases in which gross trauma such as pinching with artery forceps had been inflicted,

blood-clot in various stages of inspissation up to that of hard black concretions was found. There was, however, in no case anything in the gall-bladder comparable to human gall-stones.

FIG. 255.—High-power view of the same field as *Fig.* 249, showing the granular lipoid-containing cells. (× 200.)

THE CHEMICAL FINDINGS

In those experiments in which estimations were made of the cholesterol in the bile aspirated from the gall-bladder as well as of the blood-cholesterol, the level of the cholesterol in the bile was always found to be much less than in the blood. Thus in one animal (Experiment 6) the blood-cholesterol rose to 1300 mgrm. per 100 c.c., while the bile-cholesterol was only 340; and in another (Experiment 8) in which the blood-cholesterol rose to 1350, the bile was only 170.

The question whether there is a direct relation between the level of the cholesterol in the blood and in the bile is in dispute, and while some theories of gall-stone formation are based on the view that there is such a direct relation, others deny that raising the blood-cholesterol has any influence at all on the bile-cholesterol (Dostal and Andrews). Most of the present experiments are not capable of being brought to bear on this problem, because in most of them relatively gross trauma was deliberately inflicted on the gall-bladder, and it is certain that some of the rise in the bile-cholesterol must have been due to this. But in some of the experiments the possibility that raising the blood-cholesterol raises the bile-cholesterol cannot be dismissed. For example, in Experiment 6 no injury was done to the gall-bladder other than that associated with pricking it with a fine hypodermic needle to aspirate the bile for the estimation. At the start of the experiment the cholesterol reading was 50 mgrm. per 100 c.c. of bile; at the end of fifty-seven days' feeding, when the blood-cholesterol was 1300, the bile-cholesterol was 340; and on the cholesterol feeding being omitted, the bile-cholesterol fell to 113 and subsequently to 100. In another similar experiment (Experiment 8) the bile-cholesterol rose from 120 to 170 with cholesterol feeding, and fell to 110 on its omission.

While it must be admitted that the rabbit is not a very satisfactory animal for this type of experiment owing to the small size of the gall-bladder, the above results suggest that a raising of the blood-cholesterol is accompanied by a raising of the bile-cholesterol, but small in degree in comparison with that of the blood.

DISCUSSION

The present experiments thus confirm those of Illingworth in showing that it is quite easy to produce a typical strawberry gall-bladder in rabbits by a combination of cholesterol feeding and the production of chronic inflammatory changes. The evidence, however, is against Illingworth's conclusion that the cholesterol comes from the bile and is deposited in the gall-bladder wall owing to a breakdown in a normal absorptive mechanism, and the following summarizes the evidence against this conclusion :—

1. In those animals in which the inflammatory reaction was confined to the serosa, the deposits of cholesterol too were confined to the serosa.

2. Similar deposits of cholesterol were present in other chronically inflamed areas—for example, the incision in the abdominal wall and the adhesions around the gall-bladder.

3. Moreover, tying the cystic duct before the cholesterol feeding started did not prevent deposits of cholesterol in the inflamed gall-bladder (Experiments 11, 13, 17, 18, 19).

4. Finally, there is the chemical evidence, which, so far as it goes, suggests the blood rather than the bile as the source of the deposits of cholesterol in the gall-bladder, in that the blood figures were always so much higher than those of the bile.

The evidence against the view that the experimentally produced cholesterosis gall-bladder of rabbits results from a breakdown in a normal cholesterol-absorbing mechanism thus seems conclusive. There is equally little justification for postulating a breakdown in a normal cholesterol-secreting mechanism, and the obvious explanation is that a chronically inflamed gall-bladder in a hypercholesterolized rabbit is liable to have cholesterol deposited in it from the blood in the same way as other chronically inflamed areas. The cholesterol is probably carried by wandering phagocytic cells (Zinserling), and, as already noted, such lipoid-containing cells can in most cases be clearly demonstrated (*see Fig.* 255).

APPLICATION OF EXPERIMENTAL FINDINGS TO MAN

Admitting that typical strawberry gall-bladder can be produced in the rabbit and that the cholesterol is deposited from the blood in phagocytic cells, the question arises of the application of the experimental findings to man. The metabolism of cholesterol in herbivorous animals is so different from that in carnivorous animals that very great caution must be exercised before applying conclusions derived from one to the other. In man cholesterosis gall-bladder occurs without the high blood-cholesterol which is necessary in the rabbit, and usually without gross inflammatory changes in the gall-bladder, so that in the present case caution is particularly necessary. All that can be claimed, therefore, from the present experiments is merely that they provide an alternative possibility to the usual theories of the mode

of development of cholesterosis gall-bladder, the proof or refutation of this possibility depending on investigations in man.

The question whether the condition represents a depositing of cholesterol out of the blood similar to that which occurs in other xanthomatous areas is not merely of academic interest, but of practical importance in treatment. If the general view of the etiology is correct, a marked cholesterosis gall-bladder indicates an organ one function of which is so seriously impaired that the question of removal arises as a rational form of treatment. And since the condition cannot usually be diagnosed from external inspection alone, the surgeon might feel called upon when operating on a case in which the symptoms were equivocal to remove a gall-bladder which appeared normal externally, in order to be quite sure he was not leaving behind such a functionally abnormal organ. And, in actual fact, the demonstration of these deposits in an otherwise healthy gall-bladder that has been removed by operation is commonly regarded by surgeons as a pathological justification for the operation of cholecystectomy. If, however, cholesterosis gall-bladder represents merely a depositing of cholesterol out of the blood, then, provided the functional tests are satisfactory and the organ appears otherwise healthy, there would seem to be no more indication for removal of the gall-bladder for the condition *per se* than there is for the removal of other xanthomatous areas.

Illingworth has described cases of cholesterosis gall-bladder associated with symptoms referable to the gall-bladder which were cured by cholecystectomy. The tests of gall-bladder function were normal in these cases. It is difficult to see in what way deposits of cholesterol in the mucosa of an otherwise healthy and normally functioning gall-bladder could cause symptoms, and it seems certain from the figures which Berendes gives on the high incidence of the condition in routine post-mortem examinations that in the majority of cases cholesterosis gall-bladder is unassociated with symptoms. Further clinical investigations on the lines of those of Illingworth would therefore be of great interest, and might throw light on a point of considerable importance in gall-bladder surgery—that is, whether it is justifiable to remove a gall-bladder on symptoms alone in the absence of calculi or other external evidence of gall-bladder disease.

The present investigation provides no evidence on the relation, if any, between cholesterosis gall-bladder and gall-stones, and, owing to the differences between animals and man in the composition of the bile and in metabolism generally, it is likely that this question will only be solved in man. That the two conditions are causally related is suggested by numerous clinical cases in which cholesterol gall-stones have been found associated with cholesterosis gall-bladder, and in which it is very tempting to assume the sequence of diffuse cholesterosis, cholesterol polyposis, and finally cholesterol gall-stones. On the other hand, it has already been noted that it is only in a minority of cases that cholesterosis is associated with gall-stones (Berendes), and the possibility that the simultaneous presence of the two conditions is coincidental cannot be dismissed. Thus in a gall-bladder recently removed from a middle-aged woman, both diffuse cholesterosis and cholesterol polyposis of the gall-bladder were associated with calculi composed predominantly of pigment and calcium, and containing only 30 per cent cholesterol, suggesting that in this case at any rate the two conditions were merely coincidental. In the present state of our knowledge, therefore, the relation between cholesterosis

gall-bladder and gall-stones is too obscure to justify any practical conclusions, and certainly too obscure to justify anything in the nature of prophylactic removal of the gall-bladder.

SUMMARY

1. Experiments are described confirming those of Illingworth in showing that in the rabbit cholesterosis gall-bladder similar histologically to that of man can be produced by a combination of raising the blood-cholesterol and inducing chronic inflammatory changes in the gall-bladder.

2. It is concluded that the experimental condition arises by a direct depositing of cholesterol from the blood in phagocytic cells similar to that which occurs in other inflamed areas, rather than through an interference with a cholesterol-absorbing mechanism.

3. The practical importance of this is discussed, and its possible bearing on the surgery of the gall-bladder.

This work was carried out by me in the Bland-Sutton Institute of Pathology of the Middlesex Hospital as Streatfield Research Scholar of the Royal College of Physicians of London and the Royal College of Surgeons of England, and I have much pleasure in acknowledging my indebtedness to Professor James McIntosh, Director of the Bland-Sutton Institute of Pathology, for providing me with facilities for carrying out the work and for his kindness and help. I also wish to thank Professor E. C. Dodds, Director of the Courtauld Institute of Biochemistry, for his kind help with the chemical estimations.

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SHORT NOTES OF RARE OR OBSCURE CASES

PRIMARY CARCINOMA OF THE LIVER: SUCCESSFUL LOBECTOMY

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PRIMARY carcinoma of the liver is an uncommon condition, and a victim is very fortunate when the disease is discovered while still localized to the left lobe, and so lends itself to removal.

HISTORY AND EXAMINATION.—W. M., male, aged 59. Three years ago while lifting a heavy weight, the patient suddenly felt a 'tearing' sensation in the pit of the stomach. Two days later he felt faint and vomited a considerable amount of blood, estimated at two pints. He was admitted to hospital and a bismuth meal showed no evidence of gastric abnormality. His condition improved and he returned to work, but found that any effort made while in a stooping position caused epigastric discomfort. Four months ago continuous abdominal pain supervened which bore no relationship to food, rest, or exercise, and the patient noticed that he was losing energy and becoming progressively less fit for work.

On Feb. 6, 1934, the patient discovered an epigastric swelling which led him to consult Dr. C. W. Seccombe, of Southall, who diagnosed hepatic enlargement, and recommended further investigation. The patient was accordingly admitted to hospital, and presented himself with an obvious swelling in the left epigastrium, which was the size of a coconut. The tumour was definitely tender, firm in consistency, and evinced transmitted aortic pulsation, which was less conspicuous in the genu-pectoral position. A blood examination showed no abnormality beyond a slight leucocytosis, and pancreatic tests were normal. A bismuth meal indicated the presence of a solid swelling between the stomach and the left cupola of the diaphragm. It was decided that a laparotomy should be performed.

OPERATION (Feb. 27).—General anæsthesia. The abdomen was opened through a left upper paramedial incision. The left lobe of the liver presented itself as a rounded mass, slightly irregular on the surface, obviously congested, and of elastic consistency. An exploring needle withdrew blood. It was then recognized that the tumour was in all probability carcinomatous, and the intestinal tract was carefully searched for a primary growth. The examination was entirely negative, the right lobe of the liver appeared to be normal, and the peritoneal cavity contained no free fluid. It was then decided that the hepatic tumour was probably a primary carcinoma, and as the patient's condition was satisfactory an attempt to remove the left lobe was justifiable. In order to gain adequate exposure the rectus muscle and parietes were divided in an upward and outward direction from the level of the umbilicus to the costal margin. The falciform and left coronary

ligaments were rapidly divided, which permitted the left lobe to be drawn to the right so as to expose the portal fissure. Brief dissection revealed the left hepatic artery and the left branch of the portal vein, which were secured with clamps. A few interlocking sutures were inserted into the isthmus of liver substance connecting the two lobes, and the remainder of the liver tissue was divided with an electro-cautery (*Fig.* 256). After removal of the left lobe the left hepatic artery and portal

FIG. 256.—A section through the left lobe of the liver. The left branch of the portal vein, the left hepatic artery, and the left hepatic duct are seen immediately in front of the charred surface, which was divided with an electro-cautery knife.

vein were ligatured. Hæmorrhage from the raw surface of the liver was insignificant. A drainage tube was inserted and the wound closed. A pint of intravenous saline was administered towards the end of the operation, and 250 c.c. of blood were transfused two hours later.

Convalescence was somewhat disturbed by ileus (which responded to pitressin), and hæmatemesis, which persisted for four days. The hæmatemesis was presumably due to congestion of the gastric veins following ligature of the left branch of the portal vein. The patient was discharged to a convalescent home sixteen days after the operation.

PATHOLOGICAL REPORT (*Fig.* 257).—On microscopic section the tumour was found to be composed of irregularly arranged cuboidal and spheroidal cells, and was considered to be a hepatoma arising from the liver parenchyma. The normal liver tissue showed no evidence of cirrhosis.

SUBSEQUENT HISTORY.—Although the patient's condition improved at the convalescent home, he failed to regain his normal strength, and after two weeks subcutaneous nodules appeared in the region of the umbilicus. On section these

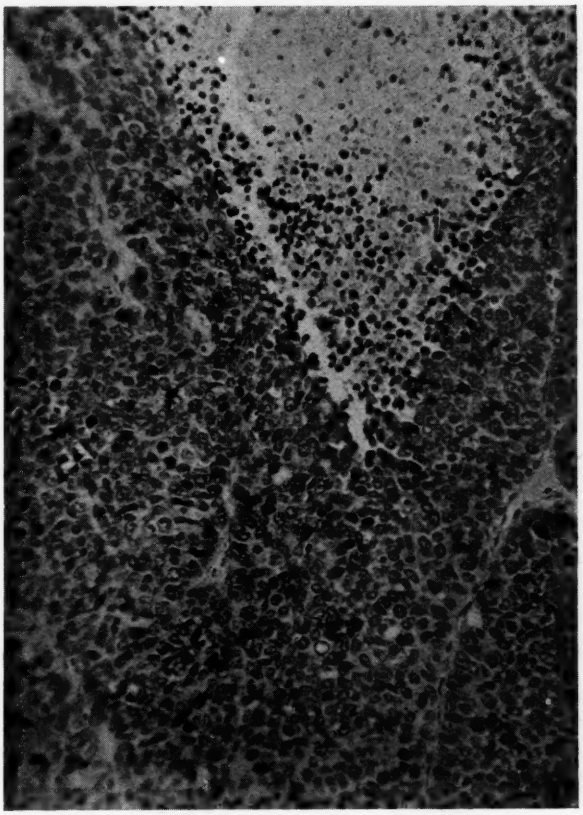

FIG. 257.—Microscopic section of the tumour. (× 200.)

proved to be identical with the liver growth, and were presumably secondary deposits which had spread along the lymphatics in the falciform ligament. The condition of the patient steadily deteriorated and he died on April 16.

POST-MORTEM EXAMINATION.—At necropsy the right lobe of the liver was found to be enlarged and studded with secondary growths. The left lobe was absent and the scar of its removal was clean. There were a few small secondaries in the peritoneum overlying the right kidney, and also in the left hilar glands. One small nodule was present in the heart. There was no lesion in the stomach, duodenum, small intestine, or colon, and the case appeared to be one of primary carcinoma of the liver.

I am indebted to Mr. L. Fatti, F.R.C.S., of the Hillingdon County Hospital, for the subsequent history of this case.

A DERMOID CYST OF THE GREAT OMENTUM WITH UNUSUAL ATTACHMENTS

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Cysts of the peritoneum are rare: of this group omental cysts are the least frequent, and are of five types: (1) Lymphatic or chylous; (2) Enterogenous (deriving from sequestrated congenital intestinal diverticula or Meckelian remnants); (3) Urogenital cysts, usually of nephrogenic origin; (4) Dermoids and teratomata; (5) Hydatid cysts. The following case is a dermoid cyst of the omentum:—

A married female, aged 60, a diabetic, was admitted to the Cardiff Royal Infirmary on the second day of a typical attack of acute appendicitis. Abdominal examination revealed, in addition, an extremely mobile tumour, the size of a golf ball, which could be felt in the left hypogastrium: the swelling was painless, uniformly smooth, and could be pushed with ease in all directions. On vaginal examination the tumour appeared to be unconnected with the pelvic organs. The patient was unaware that her abdomen contained a lump, and there had been no symptoms arising from it.

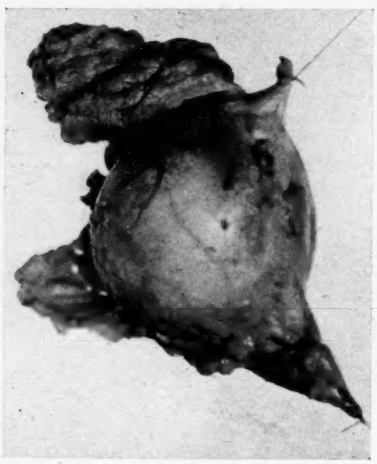

Fig. 258.—Macroscopic appearance of the tumour.

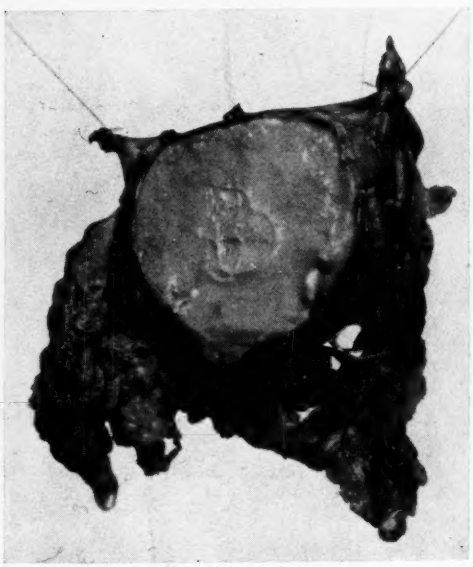

Fig. 259.—Cut surface of the cyst.

Operation.—After insulin had been administered, immediate operation for appendicitis was carried out through a right paramedian incision: an acutely inflamed appendix was removed. I then passed a hand into the abdomen and delivered into the wound a soft spherical mass enmeshed in the great omentum and attached by dense fibrous strands to the anterior abdominal wall in the region of the umbilicus, to the mesenteric border of the ileum about three feet from the ileocæcal valve, and also to the apex of the bladder. There were no connections with the internal genitalia, which were seen to be normal. The swelling with some adherent omentum was removed without difficulty and the abdomen closed. Convalescence was uneventful.

PATHOLOGY.—*Fig.* 258 illustrates the macroscopic appearance of the tumour and its intimate relation to the omentum. To the left of the picture a strand of silk is tied to the fibrous band that ran from the tumour to the ileum. In view of the attachments the diagnosis of vitello-intestinal cyst was made; a urachal origin was also considered in view of the bladder attachments seen at operation. On section, however, the tumour was found to be a typical dermoid cyst containing sebaceous material and hair. *Fig.* 259 shows the cut surface of the cyst.

COMMENTARY

Before operation the mobility of the tumour suggested a mesenteric cyst, but the ease with which the tumour could be manipulated in a vertical as well as a horizontal axis discounted this diagnosis. There are few recorded omental dermoid cysts. Mantel[1] (1895) described a dermoid cyst of the great omentum. Meckel[2] (1815) writes, "Ruysch found in a woman who had long suffered from dropsy, a tumour the size of a fist, filled with a white pulpy mass and locks of tangled hair, situated in the omentum which was everywhere as thick as a finger, and firmly adherent to the peritoneum." F. Niosi,[3] in an article on mes nteric cysts, described a large symptomless lump removed from the omentum which was teratomatous in nature, containing epithelial formations, suprarenal tissue, and an area of chorio-epithelioma in addition to multiple small cysts. This tumour was attached to the mesocolon and was probably of mesenteric rather than omental origin. D. P. D. Wilkie[4] recorded a case of intestinal obstruction in a boy of 15 due to an omphalo-mesenteric cyst in which the attachments closely resembled those in the case reported above, but the presence of glairy mucoid fluid in the cyst proved the tumour to be enterogenous in origin. Stanford Cade (quoted by Arthur Evans[5]) removed an omental cyst, but microscopical examination showed a lining of columnar epithelium lying on muscularis mucosæ, and this led Evans to classify the case as a developmental enterogenous cyst.

The origin of omental dermoids is obscure. Wilms[6] believed them to be due to imperfect closure of the abdominal plates; other observers postulate an ovarian source, by development from a supernumerary ovary, from a free ovum, or from a ruptured ovarian dermoid. Such hypotheses remain unsubstantiated. The origin in the case recorded may well be from omphalo-mesenteric or allantoic remnants in view of the attachments present.

I am grateful to Professor A. W. Sheen, Director of the Surgical Unit, for his help and advice and for permission to publish this case; also to Mr. Arthur Evans whose work on enterogenous cysts was so helpful and who took an interest in this case.

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PROGRESSIVE POST-OPERATIVE CUTANEOUS GANGRENE

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In the *Annals of Surgery*, December, 1932, Patterson describes under the heading of "Progressive Post-operative Cutaneous Gangrene", a case of extensive streptococcal ulceration of the skin, with recovery. On searching the literature he was able to collect only twenty similar cases, and, with this small number recorded, one is justified in assuming that the condition must be rare, as such characteristic and remarkable cases would, when met, probably call for publication more frequently.

All the cases so far recorded follow each other closely in detail, and the description of their appearance is so similar that it seems possible to class them as a definite clinical entity. As the title suggests, the condition is a slow but progressive ulceration of the skin in the neighbourhood of a recent operation wound. This ulceration, of characteristic appearance, continues to extend remorselessly in spite of all conservative treatment, and is due to an unusual streptococcal infection belonging to the anaerobic class. The majority of cases, if not all, appear to develop in the puncture wound of a deep tension suture following operations for empyema, perforated acute appendicitis, and perforated duodenal ulcer, and it seems reasonable to suggest that this unusual type of infection originates from within the bowel or lung.

A search of the English literature, which has been kindly carried out by the Librarians of the Royal Society of Medicine, has failed to discover any reference to a similar case, with the only exception in *The Medical Journal of Australia*, 1930.[1] Here under the heading of "Spreading Gangrenous Inflammation" a case is recorded of apparently similar infection, arising in an empyema wound, in which the ulceration ultimately extended over the whole of the back, from neck to buttock, and death followed. For these reasons it is thought that the following recent case should be recorded.

Male, aged 57 years. Previous health good, except for indefinite symptoms of dyspepsia with no characteristic sequence. On June 5, 1933, he suffered from severe abdominal pain, diagnosed as perforated duodenal ulcer, and laparotomy was performed within six hours of onset. A perforated anterior chronic ulcer in the first part of the duodenum was found. This was closed by one purse-string suture and two tags of omentum were stitched over the repair to assist. There was very little soiling of the peritoneum, and the abdomen was closed in layers with continuous catgut sutures and three deep tension sutures of silkworm gut were used, each passing through skin and rectus muscle on both sides of the incision. No drainage was employed. The post-operative period was uneventful. The tension sutures were removed on the eighth day. About the tenth day a bead of pus escaped from the right puncture wound of the upper tension suture and also from the left wound of the lowest tension suture. These two small puncture wounds became more inflamed, ulcerated, and slowly spread very definitely laterally, with little tendency to extend in the long axis of the body, thus leading to two

separate ulcers, one on either side of the incision. There was no encroachment of this process towards the mid-line, and the original incision remained firmly healed throughout with a small margin of healthy skin on each side between it and the spreading ulcers. The spread of the ulcers was very striking. The advancing edge of each ulcer was similar, and throughout tended to spread outwards and in no other direction. The process was preceded by a wide bluish inflammatory zone about 2 to 3 cm. wide, and immediately internal to this was a narrow rim of dry gangrenous tissue less than 0·5 cm. wide. As this advanced it left behind a thick grey slough which was firmly adherent, and this only slowly separated some ten days later, leaving a clean healthy granulating surface. From beneath this slough there was a constant discharge of pus, and many beads could be expressed by gentle pressure.

The later stages were remarkable. The outer edge of each ulcer was inflamed and advancing, while the old original area near the mid-line was clean and healthy and actually epithelizing over. The involved area was exquisitely tender throughout, and the temperature ranged between 99° and 103°, though apart from this there was remarkably little toxæmia. The whole inflammatory process was entirely confined to the skin and subcutaneous tissue, the abdominal muscles being unaffected and remaining free from infection and functioning normally throughout. The rate of spread was slow but steady. At the end of six weeks each ulcer was about 6 by 3 in., with a bridge of normal skin containing the healed incision separating the ulcers. This gives an average daily advance laterally of approximately 4 mm., while very little extension upwards or downwards had occurred. Cultures from the pus had grown a scanty growth of streptococci, and for this reason treatment by excision had been rejected for fear of opening fresh planes of tissue and disseminating the infection. During this period many different lines of treatment had been employed, including serum, Carrel-Dakin, and other antiseptics, blood transfusion, sodium nucleinate, ultra-violet, and even infra-red, rays. All lines of local and general treatment were singularly conspicuous for their complete failure to allay, even in the slightest degree, the steady progress of the condition.

At this stage Patterson's case was brought to notice, and it was decided to excise completely the inflammatory area forming the advancing edge. This was done on July 21, 1933. The excision was made wide in healthy tissue outside the inflammatory area and carried internally until the region of healthy granulating tissue was reached, thus completely excising the advancing edge of each ulcer down to, but not exposing, the muscles. A large raw area was left after this extensive excision, and two silkworm sutures, one on either side, were inserted to endeavour to reduce this by drawing the skin edges lightly together. There was no untoward general reaction following this, but seven days later all four suture puncture wounds were infected in the same way and showed gangrenous patches round each wound, and pus could be expressed from the deeper surfaces of each. The rest of the wound, however, was extremely healthy. These four points were excised wide of the inflammatory process and no sutures were used again. On two further occasions the extreme edge of the wound developed an area of gangrene and each required excision, the first ten days later, and the second six days following that. The last excision was on Aug. 16. From then onwards the healing was rapid, epithelium growing in with remarkable rapidity. After the last excision an enormous area of skin had been removed, and in view of the previous experience with the use of stitches it was not possible to draw the skin edges together. It was estimated that

well over fifty square inches of skin had been removed, yet within six weeks the whole of this, except for a minute area, had epithelized over and the patient was home, the only dressing used being flavine and paraffin for the first ten days or so, and then a simple saline dressing. *Fig.* 260 shows the condition of the ulcers immediately prior to the first operation, and *Fig.* 261 shows the final result.

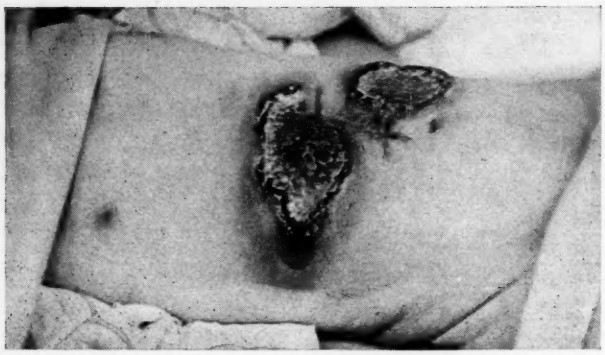

FIG. 260.—Showing the two ulcers with the gangrenous edge and the healed incision immediately before the first operation for excision.

FIG. 261.—Showing the narrow scar resulting from the very wide excision of skin.

BACTERIOLOGICAL REPORT (Dr. Facey).—Examination of a piece of tissue from the wound gave the following result: On direct examination two distinct types of Gram-positive cocci were seen, one having the appearance of a streptococcus and the other a staphylococcus. Primary cultures on blood-agar gave no growth aerobically, but a growth of streptococci and staphylococci anaerobically. No growth occurred in broth. On sub-culture both organisms grew aerobically, though the streptococococci grew much more profusely under anaerobic conditions: 5 c.c. of a strong emulsion of a twenty-four-hours culture of the streptococci proved non-pathogenic when injected into the peritoneal cavity of a guinea-pig.

SUMMARY

1. A case is described of progressive post-operative gangrenous ulceration, of which only about twenty cases have been recorded, mainly in America.

2. This ulceration is of characteristic appearance, and all recorded cases resemble each other very closely. The progress of the ulcer is slow but steady, until, if left, an enormous area may be involved and death follows.

3. No treatment appears to be of any avail in checking the inflammatory spread except wide excision of the advancing edges of the ulcer and surrounding discoloured area. This can confidently be carried out without fear of disseminating the infection, and is successful in curing the condition.

4. The infection seems to develop in relation with the use of tension sutures, and in no circumstances should these be employed after excision of these ulcers.

5. The organisms are anaerobic streptococci and staphylococci, and it is assumed that the source of this unusual type of organism is probably from within the alimentary canal.

REFERENCE

[1] POAT, *Med. Jour. Australia*, 1930, ii, 398.

A UNIQUE "SKINNING" ACCIDENT

ON Aug. 30, 1934, Mrs. N., aged 38, stepped off the cab of a lorry which her husband was driving; she fell down, and the back wheel of the lorry ran over the outer part of her left thigh and leg. The whole thickness of the skin with the subcutaneous tissue was stripped clean off the leg—from the groin to the ankle (*Fig.* 262). On admission to the local hospital, a large flap of skin was found

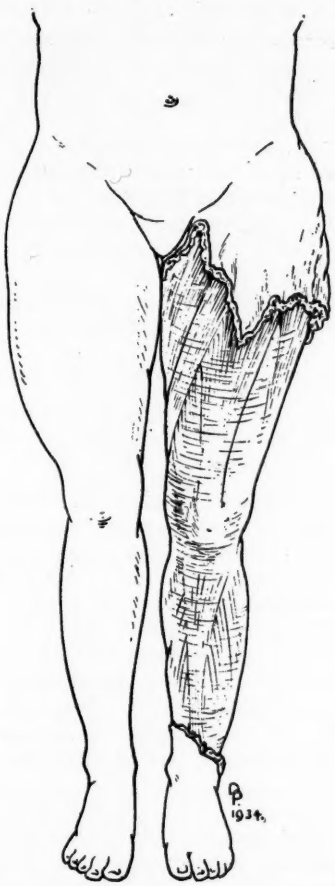

FIG. 262.—Showing how the skin and subcutaneous tissue were stripped from the patient's leg.

attached to the gluteal region. This was cut off. The patient suffered from a severe degree of shock, from which she rallied to some extent after continuous saline infusion. On Sept. 4 her condition was so far improved that it was considered safe to amputate; but she died a few hours later.

NOTE.—The skin must have been pinched along the outer side of the leg and split on the inner side. The whole thickness of the skin and subcutaneous tissue had been stripped off down to the deep fascia, through which the muscles could be plainly seen.

REVIEWS AND NOTICES OF BOOKS

The Origin of Cancer. By J. P. LOCKHART-MUMMERY, M.A., M.B., B.C. (Cantab.), F.R.C.S., Senior Surgeon, St. Mark's Hospital, etc. Large post 8vo. Pp. 150 + x, with 29 illustrations. 1934. London: J. & A. Churchill. 10s. 6d. net.

THE transmutation of one or more of the cells of the body into a cell with unchecked and limitless powers of proliferation appears to be the event which determines the origin of cancer. The transmutation is either the effect of changes in the intracorporeal environment of the cell, or is a primary change within the cell itself. Mr. Lockhart-Mummery's book states the case for the second of these two views. His theory, first put forward in 1932, is that if the growth-rate of somatic cells is controlled by certain genes contained in the nucleus of the cell, and "if these genes have been mutated in such a way that the normal rate of growth is increased, that is to say if mitosis of the cell occurs at more frequent intervals than is normal for that particular tissue, then it follows that a tumour must result" (page 37).

The author frankly admits that the 'gene' is a concept only, but in his view biology is reaching the position of physics, which has long dealt familiarly with such ultra-sensual concepts as the electron. He claims for the pathologist the freedom long conceded to the poet and lately seized by the physicist.

> As imagination bodies forth
> The forms of things unknown, the poet's pen
> Turns them to shapes, and gives to airy nothing
> A local habitation and a name.

The question arises whether it is necessary, in order to account for an acceleration of the rate of multiplication of a cell or group of cells, to assume an essential change in the machinery of the cell, a gene mutation. Small external interferences or a mere fall of temperature may make a clock go faster, apart from any permanent alteration in its machinery. Is not the gene theory too long a jump beyond the known facts—hypothesis, in fact, rather than a theory?

Mr. Mummery admits "Very marked variations may occur as the result of changes or abnormalities in the environment, as, for instance, when a child is born without a limb, or part of a limb, due to intra-uterine damage from adhesions, etc. Or when as the result of disease abnormalities of structure or function occur. Such abnormalities are clearly the result of the environment, but at present we cannot always distinguish between changes in the adult structure due to factors in the environment, and changes due to the genes which have been inherited" (page 74).

It would seem simpler, and therefore more scientific, to assume that in the cell about to be cancerous some permanent and generally irreversible change, not necessarily a gene-mutation, is produced by a change in the environment. In this connection Sampson Handley's demonstration that precancerous areas are areas in which lymph-stasis has been set up, usually by previous lymphangitis, must not be forgotten. It is true, as Mummery points out, that the lymph-stasis theory does not offer any precise explanation of the intracellular events which change a normal epithelial cell into a cancerous one, though Handley suggests that the cell in a condition of lymph-stasis is cut off from the chemical influence of the rest of the cell-community, and consequently reverts to its ancestral condition as an autonomous unicellular organism.

The strongest argument in favour of the gene-mutation theory of cancer is derived from a study of the tumours of homologous twins. The facts about these tumours are certainly mysterious and arresting. Taking Burkhard's case of the twins who both developed cancer of the left breast simultaneously, it would appear that in the original ovum which divided into a twin-ovum all the arrangements for an eventual and predestined cancer of the left breast were already perfected without regard to the post-uterine life history of the twins concerned.

Surely, however, these predestined cancers must form but a small fraction of the total of malignancy. The occupation cancers, the cancers due to infections such as syphilis or to trauma or exposure to light, are obviously excluded from them. They hardly supply a broad enough basis for rejecting the belief that as a rule the conditions leading to cancer are first established during the post-uterine life of the individual.

Enough has been said to show that Mr. Lockhart-Mummery's book supplies much food for thought, especially for those who, like Sir Thomas Browne, love to pursue their reason to an *O altitudo*. It must be added that the author has expressed himself in clear and lucid terms which leave no doubt as to his meaning, and that even those who disagree with the book's conclusions must admit its intellectual appeal before recording a ' not proven ' verdict.

Surgical Anatomy and Physiology. By NORMAN C. LAKE, M.D., M.S., D.Sc. (Lond.), F.R.C.S., Senior Surgeon, Charing Cross Hospital, etc.; and C. JENNINGS MARSHALL, M.D., M.S. (Lond.), F.R.C.S., Surgeon, Charing Cross Hospital, etc. Demy 8vo. Pp. 888 + x, with 238 illustrations. 1934. London: H. K. Lewis & Co. Ltd. 30s. net.

THE authors have considerably exceeded the scope of their work as set out in the preface, for besides surgical anatomy and physiology the book contains a good deal of pathology and much treatment, both operative and non-operative. There is an excess of operative detail, and even if it is admitted that a general outline of common operations should be included in a work on anatomy, it is open to question whether some of the operations chosen for description are in general use. Much of the physiology is biochemical, describing methods of investigation of use in diagnosis of disease. The inclusion of such material appears a helpful innovation, but care should be taken that only views which have stood the test of time and which are generally accepted should be included: such a book is no place for theories which may be exploded long before the edition in which they appear is out of print.

Some of the figures are original and helpful, but others ' after ' well-known text-books are inaccurate. We have compared *Figs.* 49 and 117 with the originals in Cunningham's *Anatomy*, and it is difficult to realize that they are copies, and in each are obvious inaccuracies.

The authors set out upon a well-intentioned and much-needed project, and it is to be hoped that at an early date they will take advantage of a second edition to correct glaring errors which, in its present form, debar what might be a really useful book from being safely included in the library of a student, who will probably be unable to sift the wheat from the chaff.

La Pratique chirurgicale illustrée. By VICTOR PAUCHET. Fasc. XIX. Super royal 8vo. Pp. 295, with 249 illustrations. 1934. Paris: G. Doin et Cie. Fr. 70.

THIS volume contains twenty-one articles, ten of which deal with resections of colon and rectum, closure of colostomy, colo-vesical fistula, vesico-vaginal fistula, and congenital malformations of the anus. The remaining subjects dealt with are retropharyngeal abscess, cholecystostomy, anastomotic ulcer, extra-mucosal pylorosplasty, gastrectomy, spina bifida, and medullary grafting for pseudarthrosis. Dr. Pauchet and Dr. P. Le Gac each contribute eight articles, Dr. G. Luquet two, Drs. A. Tierny, G. Pascalis, and J. Sénèque one each.

The high standard of excellence reached in previous volumes is maintained, thanks to the excellent illustrations by Monsieur S. Dupret. Articles which call for special comment are those on the method of extra-mucosal pyloroplasty (G. Luquet), closure of left-sided colostomy (P. Le Gac), and the Hartmann operation for low pelvic colon growths (G. Luquet). Dr. Luquet employs a median incision for the Hartmann operation. We have found a long oblique iliac incision to give better access and facilitate the operation in a considerable number of cases, and we like to divide the upper end of the colon outside the abdomen at the end of the operation instead of at the commencement.

A simple perineal excision of the rectum on a magnified Whitehead principle is described for tuberculous ulceration of the rectum. The occasions when this is either desirable or possible must be few. If tuberculous ulceration is so extensive as to justify a radical excision it is usually associated with peri-rectal inflammation, fixation of the rectum, and often with inflammatory invasion of the ischio-rectal fossæ, etc., conditions most unfavourable for this type of operation.

X-ray and Radium Injuries: Prevention and Treatment. By HECTOR A. COLWELL, M.B., Ph.D., M.R.C.P., D.P.H.; and SIDNEY RUSS, C.B.E., D.Sc., F. Inst. P., the Barnato Joel Laboratories, Middlesex Hospital. Demy 8vo. Pp. 212 + xii. Illustrated. 1934. London: Oxford University Press. 14s. net.

THIS is the only text-book of its kind in the English language. The outstanding features of these injuries are presented in a form which will be very helpful, not only to all radiologists but to all medical practitioners, and as references to the literature on the subject are freely given, the student who wishes to pursue the subject further will find this book invaluable.

After the opening chapter, which deals with protection, and in which full credit is given to the work of the X-ray and Radium Protection Committee of this country, the subject is treated in a series of chapters dealing with the various systems of the body. Naturally the skin takes precedence, and the story of the damage done to early X-ray workers and patients as a result of exposure to radiations is briefly retold. The effects of X rays and radium on the skin are all carefully described. The various skin reactions, both early and late, are fully dealt with, and special mention is made of the work of Gillies and McIndoe in the treatment of chronic radio-dermatitis and radio-necrosis.

In succeeding chapters the effect of X and gamma radiations on the respiratory tract, the circulatory system, the alimentary tract, the generative system, the urinary tract, the nervous system, and bone are dealt with. Finally, chapters on radiation sickness and poisoning by radio-active substances complete a small volume in which a mass of accurate information is presented to the reader.

This country was the first to recognize the need for a system of adequate protection in connection with X-ray and radium work. The recommendations put forward by the X-ray and Radium Protection Committee have now received international recognition and are in general use.

The readers of this book will realize how much pioneers suffered, and how much has been done to make the work of the present-day radiologist safe from similar tragedies. It is a book which can be recommended to all radiologists and as a mine of information to those interested in radiological research.

Die Wirbelgelenke. By Priv.-Doz. Dr. MAX LANGE (Münich). 10 × 6½ in. Pp. 121 + vi, with 59 illustrations. 1934. Stuttgart: Ferdinand Enke. RM. 7.

AN excellent and concise account of the vertebral articulations and of their appearance in X-rays which should be of real assistance in this difficult branch of radiology. The articulations have been examined by taking X-rays of specimens as well as by clinical investigations, and the angles necessary to show up the different parts of the vertebræ are illustrated by photographs which are in many cases clarified by a diagram. The pathological conditions are treated in a similar manner.

Narkose zu operativen Zwecken. By Dr. HANS KILLIAN (Freiburg i. Br.). Super royal 8vo. Pp. 406 + viii, with 165 illustrations. 1934. Berlin: Julius Springer. Paper covers, RM. 24; bound, RM. 26.80.

DR. KILLIAN'S book on anæsthetics, based on his own experience and supplemented by his wide knowledge of the international literature on the subject, covers the whole field of the theory and practice of anæsthesia. Exhaustive references to the bibliography given at the end of each section render the book a valuable source of reference. The theories of anæsthesia and the physiological changes that occur in the various organs are discussed with more detail than is generally found in works of this nature; the chapter dealing with the technical side of the subject, however, follows more conventional lines, whilst the descriptions of the actual methods of administration—contrasting strangely in this respect with the wealth of detail devoted to the other sections of the book—are patently inadequate. In the chapter dealing with the choice of anæsthetic there is much with which English anæsthetists will disagree, though, as Dr. Killian explains, the choice in Germany is limited by the lack of skilled anæsthetists: thus little use is made of nitrous oxide or nitrous oxide and oxygen, and it is probably for this same reason that the author condemns the use of chloroform even in obstetrics. Evipan, amongst other recently introduced drugs, is described and is

recommended as a safe anæsthetic for many operations. The volume concludes with a description of many of the anæsthetic machines in common use, and it is to be regretted that, whilst this book is in other respects completely up-to-date, obsolete models of English apparatus should be illustrated and described.

Röntgendiagnostik der Knochen- und Gelenkkrankheiten. By Professor Dr. ROBERT KIENBÖCK (Vienna). Large 8vo. Part 1. Differentialdiagnose der geschwultstigen Knochenkrankheiten. Pp. 104, with 26 illustrations. Part 2. Knochenechinokokkose. Pp. 105–192, with 26 illustrations. 1933. Berlin and Vienna: Urban & Schwarzenberg. Part 1, RM. 8.50; Part 2, RM. 7.60.

THE first two parts of a series to be devoted to the X-ray diagnosis of bone and joint disease include: (1) New growths, and (2) Echinococcus cysts of bone. The former is difficult because the classification and terminology differ so much from that used in this country. The latter is of little interest because of the rarity of the condition in this country. The illustrations are good, but are less numerous in proportion to the text than would be expected in a book on X-ray diagnosis.

Acute Intestinal Obstruction. By MONROE A. MCIVER, M.D., Surgeon-in-Chief, Mary Imogene Bassett Hospital, Cooperstown, N.Y. $10\frac{1}{2} \times 7$ in. Pp. 430 + xviii, with 62 illustrations. 1934. New York: Paul B. Hoeber Inc. $7.50.

A MONOGRAPH on acute intestinal obstruction is no longer a tedious presentation of the various types and mechanical forms of the condition. The problems presented by intestinal obstruction have been investigated from a variety of angles during the last decade and there has been a definite need for a work which attempted to evaluate the results obtained and correlate them with the clinical and pathological material. It is therefore gratifying to find a monograph on the subject published by an experienced surgeon who has previously made experimental researches which have contributed to a clearer understanding of the fundamentals of acute obstruction.

The book is divided into three sections: Part I gives a general picture of the condition; Part II deals with diagnosis and methods of treatment; and Part III discusses the experimental work which has been carried out to determine the cause of death from intestinal obstruction. The work is well balanced and the material is admirably presented. The author has evidently been careful not to allow enthusiasm to lengthen unduly any section of the book, and the chief criticism which might be applied is that he has not sufficiently stressed the practical importance of the changes taking place in the circulation and body fluids in acute obstruction—a subject on which he and his associates have carried out valuable researches. In consequence one feels that the overwhelming importance of the pre-operative treatment is not given the attention it warrants. The indications for 'decompression' of the stomach and intestines by a duodenal tube are examined critically and their values reasonably assessed.

The question of anæsthesia is not given the importance it deserves. The point is made that patients with a late obstruction are in a condition of shock which resembles that seen after severe traumatic injuries, but there is no suggestion that gum saline or blood transfusion might be beneficial. To suggest that local anæsthesia, with all the limitations it involves, is often the anæsthetic of choice is to admit that the pre-operative measures may have such a limited success in restoring the blood volume that the use of spinal anæsthesia, undoubtedly the ideal anæsthetic, is inadvisable. The remarks on shock following anæsthesia which are included in the chapter on complications would have made a useful introduction to the section in which anæsthesia is considered. Otherwise the chapters on treatment are admirable and well worth reading by every practising surgeon.

The chapters on "The Cause of Death" are very well done. An excellent and studied summary of the methods and results of experimental researches is given. The theory that the cause of death in many cases is a toxæmia is carefully examined and the relevant experimental work quoted, but one is glad to see that room is found for the view of those workers who do not believe that a toxæmia is the lethal factor in low obstructions. There is much to be said for the view that "the stagnation of blood and fluid in the splanchnic area may lead to peripheral circulatory failure and shock in this type of obstruction".

Apart from the minor points mentioned the work is excellent, and the author and publishers are to be congratulated on so admirably filling a gap in surgical literature.

Diathermy in General Practice. By ERIC PAYTEN DARK, M.C., M.B., Ch.M (Syd.), late Radiographer, Royal Prince Alfred Hospital, Sydney. With special chapters by F. A. MAGUIRE, C.M.G., D.S.O., M.D., Ch.M. (Syd.), F.R.C.S., F.R.A.C.S., and GUY P. O. PRIOR, L.R.C.P., M.R.C.S. Second edition. Demy 8vo. Pp. 219 + xvi. Illustrated. 1935. Sydney: Angus & Robertson Ltd. 17s. 6d. net.

THIS book is now appearing in its second edition. As it is intended to be of assistance to the general practitioner, who, presumably, has little knowledge of electro-technics, the opening chapters on the action of diathermy machines are not sufficiently instructive. This part of the work could be very much improved or should be omitted altogether. Simple instruction in the control of the diathermy machine would suffice. A large part of the rest of the book is made up of case records. These are of little interest to the general practitioner. A simple classified table showing the percentage of cures and the number of applications of treatment would satisfy and economize space. There are several excellent photographs showing the method of applying electrodes to various parts of the body. A unique feature is a chapter on failures. It would appear that the author had only 8 failures out of 91 cases. This ratio is much better than is obtained by most electrotherapists in this country. No mention is made of the cutting current for surgical work nor of short-wave or ultra-short-wave diathermy. No doubt the author considers that these should be left to the expert. One feels that the treatment of gonorrhœal, gynæcological, and mental conditions should be left to the expert also. This would appear to be the opinion of the writer of the foreword also, who states, "the technicalities of correct diathermy and the time required for each case make it probably best that its use should mainly lie in the hands of those specially competent."

Benign Tumours in the Third Ventricle of the Brain: Diagnosis and Treatment. By WALTER E. DANDY, Adjunct Professor of Surgery, the Johns Hopkins University. 10 × 6½ in. Pp. 171 + viii, with 120 illustrations. 1934. London: Baillière, Tindall & Cox. 22s. 6d.

THIRD-VENTRICLE tumours have long constituted one of the most intriguing group of intracranial neoplasms, partly on account of their interesting and often puzzling clinical features and partly because of their unusual histopathology. They have not, however, been regarded commonly as favourable tumours for surgical intervention, despite their benign nature. Dandy has demonstrated, however, that the third-ventricle growths are amenable to surgery and has collected an impressive total of 21 cases in which the tumour was removed, with a mortality rate of 33·3 per cent. In this present monograph Dandy has given us an intimate presentation of the clinical histories of these cases, together with notes of 47 cases taken from the literature; all of these latter were post-mortem findings, none having been correctly diagnosed during life. Dandy has analysed in detail the neurological features and has emphasized the great difficulty in arriving at a correct localization from the symptoms and signs alone. Several clinical features are indicated as being suggestive: (1) Loss of pupillary reflexes; (2) Intermittent attacks of various kinds, namely, (*a*) headache, (*b*) dizziness on alteration of posture, (*c*) bilateral weakness or numbness, and (*d*) loss of vision; (3) Possibly, loss of hearing for high tones; (4) Bilateral ptosis and ophthalmoplegia. It is obvious that those signs not of hydrocephalic origin are merely indicative of pressure upon the quadrigeminal plate. Headache, vomiting, and papilloedema are usually intense and early, and the intermittency of the first symptom often points to a ball-valve obstruction to the ventricular outflow. It is clear from the author's evidence that ventriculography offers a diagnostic short-cut which is safe and unmistakable. There always appears an enlargement of both lateral ventricles; air may or may not pass from one lateral ventricle to the other. No air as a rule enters the third ventricle; when, however, the obstruction at the foramina of Monro is incomplete or intermittent, the third ventricle may appear in the skiagram: (1) Not dilated, because it is behind the obstruction; (2) Showing a filling defect which outlines the posterior and perhaps the inferior part of the tumour; and (3) Small, upright, and mesially placed in the antero-posterior view.

From the pathological standpoint Dandy recognizes two groups of third-ventricle tumours: (1) Colloid cysts, which grow from the antero-superior aspect of the ventricle; the lining epithelial cells are frequently ciliated, and Dandy supports Sjövall in believing that they are of vestigial origin. (2) A heterogeneous group of tumours including ependymal gliomata,

choroid-plexus tumours, epidermoids (tumeurs perlées), and several other indeterminate histological types.

Dandy has employed two chief surgical approaches. A posterior 'pineal' route and a frontal or 'hypophysial' approach are the two usual operative attacks. In the case of cysts of the septum pellucidum, a third or mid-sagittal approach through the corpus callosum has also been employed. The frontal attack—used mainly when the bulk of the tumour occupies the forepart of the ventricle—necessitates the resection of an oval or transverse segment of the frontal lobe. Dandy says that no loss of function, mental or physical, has resulted from these frontal-lobe extirpations, and, so far, post-operative epilepsy has not been encountered.

This contribution makes an important landmark in the progress of neurosurgery. It is issued with a wealth of illustration and lavish disregard of expense characteristic of the American monograph-writer.

St. Bartholomew's Hospital Reports. Edited by LORD HORDER, R. G. CANTI, W. SHAW, C. F. HARRIS, H. H. WOOLARD, R. C. ELMSLIE, W. G. BALL, G. EVANS, and J. P. ROSS. Vol. LXVI. Demy 8vo. Pp. 363 + xxiv. Illustrated. 1933. London: John Murray. 21s. net.

THE staff of St. Bartholomew's Hospital, both clinical and scientific, have done some valuable team work on the autonomic nervous system in its relation to medicine and surgery. This volume contains a valuable symposium on the sympathetic nervous system which will interest physicians as well as surgeons, because it includes a case of paravertebral injection for angina pectoris; but perhaps the most interesting paper in this collection is that by Mr. R. E. Norrish on the anatomy of the sympathetic. As has been previously demonstrated by other writers on the question, this paper shows that the great variation in the minute anatomy of the sympathetic very much hampers scientific deductions from experimental and operative procedures.

Dr. Branson's review on the health of the nursing staff for a period of ten years is a particularly valuable contribution, partly because, as its conclusions are drawn from a large nursing staff, fairly exact deductions may be formed from them. Scientific observations of this kind have been long over-due, and it is a feather in the cap of the oldest hospital in London that it should be among the first to include in its reports papers of this kind. The next paper on "Pre-Reformation Nurses in England," by Miss Margaret Hart, still further demonstrates the tendency of this publication to be in the van. This is, I believe, the first paper written by a woman which has been published in the *Reports*, and is of importance because it was awarded a prize by the National League of Nursing Education of America.

Mr. G. M. Lloyd writes charmingly of the life and work of Percivall Pott, whose heroism when he fell from his horse in the Old Kent Road and sustained a compound fracture of the tibia must have been even more remarkable in that day than it would be now, owing to the dangers inherent in such an injury. The reviewer would have preferred at the head of the article the delightful portrait of Pott by Romney in the Council Room of the Royal College of Surgeons, in place of that by Reynolds in the Great Hall at St. Bartholomew's, which shows him at a more mature and less attractive age.

BOOK NOTICES

Surgery of a General Practice. By ARTHUR E. HERTZLER, M.D., Chief Surgeon, Halstead Hospital, etc.; and VICTOR E. CHESKY, M.D., Chief Resident Surgeon, Halstead Hospital. Large 8vo. Pp. 602, with 427 illustrations. 1934. London: Henry Kimpton. 42s. net.

Füss und Bein: ihre Erkrankungen und deren Behandlung. By Prof. Dr. med. GEORG HOHMANN (Frankfurt a. M.). Second edition. Royal 8vo. Pp. 380 + x, with 326 illustrations. 1934. Munich: J. F. Bergmann. Paper covers, RM. 24; bound, RM. 25.80.

Modern Advances in Diseases of the Throat. By ARTHUR MILLER, F.R.C.S. (Ed.), D.L.O., Surgeon for Diseases of the Ear, Nose and Throat, French Hospital, London, etc. Medium 8vo. Pp. 120 + xii, with 40 illustrations and 1 coloured plate. 1934. London: H. K. Lewis & Co. Ltd. 10s. 6d. net.

Cirugiá gástrica. By Dr. MANUEL CORACHAN (Barcelona). Vol. I. Crown 4to. Pp. 775 + xiv, with 374 illustrations. 1934. Barcelona: Salvat Editores, S.A. No price given.

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